SOUTHERN FOREST TYPES OF INDIA

From

A REVISED SURVEY OF

THE FOREST TYPES OF INDIA

By

Sir HARRY G. CHAMPION & S. K. SETH

WITH INTRODUCTORY CHAPTERS

By

S. KONDAS
(INDIAN FOREST SERVICE)

FOR USE IN FOREST COLLEGES

1969

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Foreword

It is a wellknown fact that Champion's Classification of Forest Types of India is a must for the forest officer whether he be the Working Plan Officer or a budding student of Forestry. The original classification has since been revised and expanded during the last visit and assignment of Sir HARRY G. CHAMPION along with Shri S. K. SETH. However, this publication has not yet reached the market and only limited cyclostyled copies are available and that too in a size too big to be carried by the students of Forestry. So Shri KONDAS'S attempt at taking out the relevant forest types that are of use to the studeuts of Forestry especially those allotted to the Southern States and compiling the same into a handbook along with relevant notes on ecology will be of immense help not only to the students but also to all forest officers.

The forest types of Southern India have been reprodued in full from the " A Revised Survey

of the Forest Types of India" while the ecology notes of the author are lucid. The incorporation of a Glossary of the technical terms used in the handbook also makes the same a compendium of very valuable information.

M. B. PETER,
Principal,
Southern Forest Rangers College.

September, 1969,
Coimbatore.

Prefactory Note

The monograph "A Revised Survey of the Forest Types of India" by Sir Harry G. Champion and S.K. Seth was issued in cycostyled form (200 copies) for the first time in 1964 pending its publication in a prinied book form. The book is not yet available. The need for a hand-book containing the Southern Ferest Types was keenly felt particularly in the field on tours by the students of this College. First a condensed form of this monograph was through of. But it was apparent that any abridgement would only impair its authority as a standard of reference and limit its usefulness. Therefore it was decided to make the Southern Types available in original.

A good knowledge of ecological principles, biological phenomena and a grasp of other classifications is presumed on the part of the forester who seeks this monograph and so the introductory chapters are highly concise in treatment with brief, sometimes passing, reference to the originals. This is undoubtedly beyond the comprehension or the students who are to be initiated into forestry. An attempt has been made to make matters easy for them by rearranging, elaborating and illustrating

the subject matter in these introductory chapters. The sequence of theme is preserved through the chapters and the student would do well to begin with the first. This will enable him to understand and appreciate and if possible reflect on the salient features of the classification rather than merely being content with its use as a book of reference.

The classification in its entirity as given in the original has been reproduced. A specially prepared glossary is appended as an aid to better understanding.

My thanks are due to Shri M.B.PETER, I.F.S., Principal, Southern Forest Rangers College, who has readily approved of my suggestion and enabled me to bring out this hand-book.

S. KONDAS,
Instructor,
Southern Forest Rangers College.

September, 1969,
Coimbatore.

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1

PHYSIOGNOMY OF FOREST VEGETATION

Vegetation and Flora :

Plants growing together in an area is known as vegetation. They influence each other profoundly and also modify the habitat. The habitat in turn acts upon and modifies the vegetation. They are not a mere assemblage of plants but form an organic entity. In relation to its habitat the vegetation has certain characteristics as determined by dominant components and they are noticed over and over again in widely separated but similar situations. A rain forest looks the same whether it is in the Andamans, the Western Ghats or Assam. Vegetation refers solely to the type of cover. The term flora means a catalogue of genera and species with which vegetation is composed of. The flora may vary from place to place for a given vegetation having similar ecological features. The rain forest of the Andamans has certain species which are not found in Assam. Briefly vegetation is general; flora is particular.

PHYSIOGNOMY

General contour and size determine the life form of a plant and accordingly we have tree, shrub, grass etc. The distinction is very useful because the appearance of a vegetation depends upon the life forms that dominated. This *general impression* conveyed to the observer is known as physiognomy and it provides an easy basis for a rough differentiation of very broad categories of vegetation. When trees dominate forest results: when shrubs dominate scrub results; when grasses prevail grasslands exists. There are many aspects of vegetation which contribute to its physiognomy and serve as distinguishing features They may be grouped under Structure, Function, and Floristics.

STRUCTURE

The structure of a vegetation means how it is built up. A forest is made up of many vertical zones called strata. Trees occupy the tallest zone in one or more layers often not well differentiated. There may be layers of shrubby undergrowth, giant herbs, tree seedlings and saplings, low herbs, prostrate plants besides epiphytes and climbers. Such a high degree of differentiation is noticed in wet evergreen forests and it becomes less and less with drier ones. The height of the top canopy members progressively comes down; fortyfive metres and over in wet forests, twentyfive metres and above in moist forests, eight to

twenty metres in dry forests and under ten metres in thorn forests. While dense canopy is characteristic of the rain forest openness marks dry forests with all gradations in between.

A short account about climbers and epiphytes is necessary because they have their niche in the general structure and contribute to the total physiognomy. Climbers particularly lianes are associated with forests and their size, situation and relative abundance depend upon the type of forest. They are the most impressive features of the semi-evergreen and moist deciduous forests but not so much of the wet evergreen. They attain great thickness, as much as a man's thigh, and length, hanging down gigantic loops passing from tree to tree linking up the crowns. They compete with trees and affect their natural form of growth by constricting their trunk and cramping their crowns. They thrive to such an extent in gaps caused by the death of trees that the young growth of trees finds it extremely difficult to find their way through the impenetrable tangle.

Epiphytes are mostly small in size with a relatively high demand for light. They secure good illuminatiou by growing attached to tree trunks and branches. They are adapted to precarious moisture supply. For the greater part they depend upon atmospheric humidity prevailing at different levels. The epiphytic content and their luxuriance gives an` idea to the degree of wetness of forests. Wet montane subtropical, semi-evergreen and wet evergreen

forests are rich in vascular and nonvascular epiphytes. Trees literally loaded with them present a curious appearance-bearded look due to heavy lichen growth on trees of sholas. Epiphytes are distributed within certain height range. Those near the tree tops tend to be very xerophytic while those farther down are more mesophytic like fimy ferns, mosses etc. Epiphytes are poorly developed, rare or absent in the dry forests.

FUNCTION

Function means ecological morphology, i.e. morphological characteristics developing in response to environment. Function treated with structure more or less makes up physiognomy.

(a) LEAF CHANGING HABIT

It is convenient to regard that evergreens shed their leaves from time to time or if all atonce only after the new leaves have developed. They are never bare at any time. Deciduous trees are those which become leafless or almost so briefly or for a few weeks or even months. The foliar periodicity of the tropical forests is supposed to be controlled by seasonal draught and of temperate forests by low temperature. This should not be confused with the leaf shedding habit determined genetically in a few species.

Bombax ceiba, *Tetrameles nudiflora* growing in the wet evergreen forest remain leafless for a short period every year or *Butea monosperma* in the flowering branches. Certain species of seasonal rainfall like teak varies its deciduous habit. If moisture is available fairly throughout it is evergreen or nearly so. As the tropical forests approach dryness the proportion of deciduous species gradually increases first in the upper then in the lower storeys. In the wet evergreen forests the emergents well above the general level of the canopy are briefly leafless while in the moist deciduous the entire top canopy goes leafless but the lower storey and undershrub remain evergreen. The leaf changing habit is an important physiognomic feature for broad division of the tropical forests.

(b) SEASONAL COLOURS

The changing colour of leaves in countless shades when expanding or before shedding is one of the most striking sights of the broad leaved forests. Wet evergreen, montane temperate forests consisting of several species deck themselves with a splash of bright red, purple, brilliant crimson, pink in countless shades during leafing seasons. This spectrum of colours narrows down as the forests becomes more and more dry. But the dry forests with gregarious species leave a blaze of single colours when they are in their autumnal tint eg. copper red of *Anogeissus latifolia* ,Flowering

causes a striking effect in the case of pure crops like teak or gregarious species like sal when flowers are produced profusely and in large terminal panicles.

(c) STEM CHARACTER

Wet evergreen trees have characteristic trunk, straight or nearly so, branchless for considerable height. In contrast to the columnar stem of trees of less moist ones the trunk is thinner in proportion to their height giving the forest as a whole " an appearance of etiolation ". In the drier forests the trunks tend to be short and branchy.

(d) ROOT CHARACTERS

Plank buttresses are another interesting feature. The buttresses are different from flutings and flanges which are only outgrowths confined to the lower part of the trunk. Buttresses arise from well developed laterals tending to run horizontally near the soil surface and due to the more rapid secondary growth of the upper side than the lower resulting in planks by the angle between the trunk and lateral roots. The size, thickness and shape of the buttresses vary considerably and they are of diagnostic value. They occur in genera of diverse families. e. g , *Bombax ceiba. Tetrameles nudiflora, Mastixia arborea, Mesua ferrea*etc. Tendency to buttressing appears to be genetically determined but the extent of development is influenced largely by

environment experiencing high rainfall combined with high mean temperature. But this does not mean that all tree species in such an environments develop buttresses.

Aerial roots form an impressive physiognomic feature of mangrove forests. *Rhizophora* sends out stilt roots from the trunk. After graceful curve they enter the soil. They branch and the branches sometimes anastomose often forming an impenetrable tangle along the water front. The innumerable pnematophores of *Avicennia*, *Sonneratia* projecting like spikes complete the picture of a typical mangrove forest. Of the *Myristica* swamps found in the valley bottom of evergreen forest of Kerala and subjected to inundation more or less throughout the year the looplike structures of superficial roots which emerge into the air and immediately bend down and enter the soil in large numbers are something characteristic.

(e) BARK CHARACTERS

The bark thickness varies considerably with the habitat. With a few exceptions, it is remarkably thin a few millimetres, light coloured and smooth in wet evergreen trees. Trees of cold and dry regions have thick, rough fissured and dark coloured bark. Thin bark comes off in granules or light flakes while thick ones chip off in the form of plates shields etc.

(f) LEAF CHARACTERS

At one extreme leaves of the wet forest trees are large rarely compound, if compound leaflets large, tend to be oblong, lanceolate, mostly entire often with a distinct acumen commonly produced into a drip tip They are generally glabrous, glaucous, leathery with thin cuticle. At the other end the leaves of drier forests have many compoud forms. Other characteristics are reduction in the size of lamina, leaflets often fine, thickened leaf blade, thick cuticle etc. There are gradations in this set of characters in between.

(g) CAULIFLORY

Normally flowers arise on shoots of the current year or of the previous year but not on leafless stems. Some tropical trees and lianes produce flowers or inflorescences on leafless stem - a peculiar feature extremely rare outside the tropics. This is noticed in small to medium size trees eg. *Baccarea courtallensis, Saraca indica. Diospyros bourdilloni, Artocarpus heterophyllous, Ficus* species etc.

(h) THORNINESS

Spines are commonly noticed in plants growing under hard and desiccating conditions. This is typified by the genus *Acacia* in different forms. Their proporation increases

on account of the protection they possess against browsing animals in contrast to those which are browsed. With the improvement in moisture condition thorny species are reduced in number or even almost absent as in the case of wet evergreen forest. But the development of spinescent emergences (prickles) does not appear to be so obviously related to severe conditions. Their presence is not understood in some of the wet evergreen trees like *Zanthoxylum Budrunga, Bombax ceiba, Flacourtia, montana.*

(i) GREGARIOUS HABIT

Species like Sal habitually growing in more or less pure crop is said to be a gregarious one. Such a crop produces a strong visual impression at different seasons. The autumnal tint of yellow of the leaves to be shed is something striking of sal in Upper India. The reeds (*Ochlandra brandisii, O. travancorica*) covering extensive areas of the higher slopes of the Western Ghats above 1000m close to the summit of hills creating mass effect is another example.

Gregarious flowering means that all individuals of a particular species occuring over a large tract do not flower every year but flower together in the same season, same year or over a number of years. This is community noticed in bamboos occuring as undergrowth in the forest. Bamboos flower at long intervals and die over large areas. When

they are in flowers they add to the general physiognomy as they do before flowering. When they do they cause considerable change in the appearance, density of crop, light conditions. root competition and affect regeneration as well. *Strobilanthes* though not to this extent, forms extensive carpet of ground vegetation in moist forests. They lit up the undergrowth when they flower which happens on a cycle ranging from three to twelve years.

(i) POLLINATION, SEED DISPERSAL ETC.

Maintenance of a forest type as a whole and survivat of species depend upon the morphological features of the species and a number of factors viz, aids to attracl pollinating agents, interval between pollination and fertilizatian, seed output, adaptations for seed dispersal, availability of seed for germination after destruction by animals, insects etc., fate of seedling etc. Each one is a critical stage and survival depends upon how best the species is helped or meets each one of the crisis.

Forests types are not characterised by a particular set of adaptations for pollination and dispersal. Variations are met with. Trees of temperate montane types are wind pollinated eg. conifers, walnut, oak etc. Many tropical trees are adapted for pollination by insects particularly bees and birds. Except in a few deciduous species flowers and generally small but they acquire attractiveness by being

massed together in large trusses of inflorescences (sal, *Balanocarpus utilis, Vateria indica*) and gain maximum display by their position at the branch terminals (teak). A number of deciduous species develop flowers when they aie bare of leaves or with tender young leaves (*Gyrocarpus jacquini, Cassia fistula, Lannea coromandelica. Sterculia urens)*. Very few species produce large and brightly coloured flowers (*Bombax ceiba, Butea monosperma. Acro carpus fraxinifolius)* which are pollinated by birds. Red and scarlet of different shades predominate flowers pollinated by birds. The flowers are generally fragrant. Other insects like ants are commonly found on the cauliflorous species suggesting their possible role in pollination. In the case of top canopy members and those growing on wind swept arreas the role of wind and water when they are lashed by monsoon rains cannot be excluded.

The colonizers on bare area, mud bank, land slips, gaps in the forest, abandoned cultivation have adaptations for wind dispersal in the form of wings attached to seed or fruit. (*Terminalia paniculata, Moringa pterygosperma*) or plumes to seeds (*Apocynaceae*) or by being light and minute like dust particles (*Adina, Macaranga*) or thin, light pods (*Dalbergia sissoo Albizzia)*. Bird dispersal is also common as seen from the numerous epiyhytic *Ficus* species, parasites on wet evergreen trees. Other species are *Broussonetia, Trema, Vitex Morus* etc. Many species of the wet evergreen produce edible fruits and achieve animal dispersal (*Artocarpus hirsuta,* by monkeys *Spondias*

mangifera Melia dubia by deers. *Zizyphus* by bears *Dillenia indica* by elephants, grass by bisons and other herbivores), It is possible that wind plays an important role in the dispersal of deciduous species and the openness of canopy is helpful. Mangrove and riparian species have adaptations for water dispersal.

FLORISTICS

While flora is a list of species of a locality, floristice of forest vegetation means their vertical distribution in various strata. It also gives other details like leaf shedding habit, the relative abundance or otherwise of the species. The structure and appearance of a forest depend upon the floristics of the locality. The Southern forest types have been analysed floristically in a rough and ready manner and are given below.

(i) WET EVERGREEN TYPE :

It consists of more than fiftyfive families of dicot. *Euphorbiaceae* and *Meliaceae* are widely represented in the top and understoreys, *Guttiferae*, *Anacardiaceae*, *Malvaceae* and *Moraceae* are prominent in the top storey followed by *Dipterocarpaceae*, *Lauraceae* and *Elaeocarpaceae*, *Myrtaccae*, *Lauraceae*. *Sapindaceae* and *Bixaceae* are prominent in the understorey. *Rubiaceae* is conspicuous in the undergrowth. *Leguminosae* are relatively uncommon in contrast

with similar type of forest in other parts of the world *Piperaceae* and other monocot families like *Liliaceae* and *Dioscoreaceae* mainly constitute the category of climbers. Flowering epiphytes belong mostly to *Orchidaceae* and *Aroidaceae* besides the nonflowering ones like ferns etc.

(ii) MOIST DECIDUOUS TYPE :

It is represented by more than fortyfive dicotyledonous families. *Leguminosae* is not only prominent in the top storey but also conspicuous in the understorey and undergrowth. Majority of climbers are legumes. Other families commonly seen in the top storey are *Combretaceae, Meliaceae, Bignoniaceae, Rubiaceae, Lauraceae*, followed by *Lythraceae, Verbenaceae, Malvaceae, Burseraceae, Apocynaceae* and *Moraceae, Euphorbiaceae, Rutaceae* and *Anacardiaceae* are well represented in understorey.

(iii) DRY DECIDUOUS TYPE :

Over forty families of dicot are found. *Leguminosae* not only dominates the top storey but also occurs conspicuously in all other strata. Others in the top storey are *Euphorbiaceae, Bignoniaceae, Combretaceae, Malvaceae, Anacardiaceae*, followed by *Ebenaceae, Rubiaceae* and *Lythraceae*. Next to *Leguminosae* it is *Rhamnaceae*, that find wide representation in understorey and other strata. The ground cover is mostly of *Labiatae, Acanthaceae, Compositae* and *Rubiaceae*.

(iv) THORN AND DRY EVERGREEN TYPES :

They contain nearly twentyfive families. In both *Leguminosae* is the commonest element In the former *Euphorbiaceae*, *Rutaceae*, *Rubiaceae*, *Capparidae*, and *Rhamnaceae*, are met with In the latter *Sapotaceae*, *Ebenaceae*. *Loganiaceae*, *Myrtaceae*, *Rubiaceae* and *Sapindaceae*, are found.

In all about twenty families represent the top storey of tropical forests.

(iv) MONTANE WET TEMPERATE TYPE

This is represented by more than thirty families, the most conspicuous being *Myrtaceae* particularly in the top storey. Other families are *Ternstroemiaceae* and *Lauraceae*, followed by *Magnoliaceae*, *Rosaceae*,*Ericaceae*, *Symplocaceae* *Euphorbiaceae*, *Elaeocarpaceae*, *Rubiaceae*, *Vacciniaceae* etc.

ENDEMISM : Species or genera restricted in distribution to a relatively small area are known as endemics. The endemic element gives a *floristic distinctiveness* to the vegetation of a locality. It is striking specially if the endemics occur gregariously. *Bentinckia Coddapanna*, an erect plm of 20 m. found on precipitous rocky slopes ranging from 760 m. to 1828 m. in certain parts of South

Travancore is an interesting example. "A picturesque feature of the reed area is the gregarious growth of the palm *Bentinckia Coddaparna* which usually cultivate the steepest portions of rocky peaks and knolls above 1220 m. elevation and contributes much towards alleviating the monotony of the vast sea of eta". Tirunelveli North working Plan 1932. There are a few other endemic palms in the Malabar region but not so imposing and they are *Pinanga dicksonii Calamus rheedii, C. brandisii, C. gambelei* and *C. huegelianus*. Next to the Himalayas the penninsulur India south of the Gangetic plains has as many as 2045 endemic species. Some of the important tree endemics are *Poeciloneuron, Chloroxylon, Ougenia* and *Butea*.

INVASIVE EXOTICS : These are alien plants which have moved from one area into another and their establishment in the new area. The common examples are *Lantana, Eupatorium* and *Prosopis juliflora*. The first two have become naturalised in many parts forming components of local vegetation while the third has progressed so far as to form a distinct feature of the Indian vegetation (salt flats of Saurashtra and usar tracts of Rajasthan).

2

DYNAMICS OF FOREST VEGETATION

STATIC RELATIONSHIP

A plant community* is more than just a collection of plants. It is an organic entity having distinctive structure and floristic composition. Each community is characterised by particular dominants. Forest communities are dominated by trees. They form the entire canopy which determines the microclimate and thereby influence the composition of the rest of the vegetation. Only species which can adjust to these conditions manipulated by the dominants come up. A study of this set up at any one time is a study in static relationship.

DYNAMIC RELATIONSHIP

Cyclic Changes

Often the microclimate created by the dominants are not favourable to their own seedlings. Only seedlings of

* Community is a genetic term of convenience which is employed to designate ecological units of any degree of extent and complexity.

such species which can come up under these conditions succeed or outside species invade and attain dominance in due course. If the earlier dominants were to regenerate they do so under the canopy of other dominants. Sal regenerates best under a mixed top canopy of some of the dominant species with which it is associated e.g. *Lagerstroemia parviflora.* 'Similarly in a mixed coniferous forest regeneration requirements of each species are seemingly better suited on ground dominated by others". This causes a cycle of changes, in the dominants with a single species or a group dominating the community during a particular phase of the cycle. These changes are not manifest. However they suggest the everchanging nature of vegetation.

Successional Changes

There are changes more obvious than the cyclic changes. Forest community grows through several stages by a long and slow process of transformation till it attains the highest form possible for a particular habitat at maturity. A state of equilibrium with factors of habitat is reched and the community becomes stabilissd. Such a fully developed community occuring naturally in an area experiencing similar or uniform site conditions is termed a formation or a climax community. This process of community development on the *same site* resulting from successive replacement of one group of plants by another is known as succession. These succe-

essional changes express the dynamic nature of vegetation in the most striking manner and are important in the interpretation of communites. This concept of vegetation climax as a part of the phenomenon of succession is a great advance in our understanding of vegetation It was Clement who first propounded it in 1916.

THEORIES OF CLIMAX

Monoclimax Theory

The Clementian concept of climax is based on monoclimax theory i. e, there could be only *one* climax community *for a given climate* and all other communities, although appearing like climaxes, are arrested developments due to certain factors. Such of them are referred to as subordinate to the climax. If for example, factors like grazing, burning or coppicing operate continuously or repeatedly the progress of a succession is checked resulting in a subclimax vegetation.

Polyclimax Theory

Of late this monoclimax theory holding climate as a decisive factor has been disputed. The present trend is towards polyclimax theory This was propounded by Tansley and Chipp in 1926 who held that certain soil conditions render climatic climax permanently impos-

sible, It considers that there could be more than one climax within a given type of climate, one for each major site type. For example, a climatic climax community may occur along with a community stabilised by local peculiarities of soil within the limits of a type of climate. The edaphic community is a form of climax vegetation (edaphic climax) because it represents the maximum development that the soil condition will permit.

Theory of climax patterns :

The climax formation is, of course, not uniform throughout. Due to minor variations in the nature of site some part of it may be slightly more suitable for one species and some other parts for another species while other areas may favour more than one species resulting in a number of fairly defined smaller communities (consociations, associations) having distinct physiognomy, structure and floristics. Each community is dominated by one species or a group of species. Like a picture formed by joining together small pieces of different colours the forest vegetation is viewed as an integrated unit of communities with different domidants continually changing, " on more or less predictable but different lines ". This view finds expression in Aubret uille's mosaic theory (1949).

In nature the cummunities, although distinguishable on ground, do not show sharp limits suggesting a mos-

aic but imperceptibly merge into another with many variations of species composition influenced by the gradients, in ecological conditions. Accordingly Whittaker views vegetation " as a pattern of populations variously related to one another corresponding to the pattern of environmental gradients ". This concept has given rise to the theory of climax patterns. The climax is explained " as a partially stabilised steady-state adapted to the whole pattern of environmental, factors in which it exists, exhibiting similar environments, but showing a continuous change along continuous environmental gradients ". According to this concept forest vegetation is considered as the product of the combined influence of all site factors namely climatic, edaphic and biotic aud other factors like availability of species and their characteristics, dispersal, chance etc. As the combined influence of site factors vary from place to place the resulting vegetation exhibits corresponding differences. Then climax should be defined on factors ofmature ecosysetm*, namely climatic, physiographic, edaphic and biotic and not solely on one determinant like climate or soil. And there cannot be an absolute (climatic) climax for any area. Further this theory considers any distinction between the climatic climax, subclimax and pre-climax not valid. The climax is accordingly to be viewed " as an average or most probable population ",

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*Ecosystem means the interacting system comprising living things, together with their nonliving habitat.

Although monoclimax and polyclimax theories still continue to be popular they do not fully explain certain facts regarding the distribution of vegetation units and their stability to remain in possession of the area and to maintain itself in terms of histuric times (stability in space and time). The case in point is mangrove vegetation. It is considered as an edaphic climax because it appears to be stable in terms of historic time This is not correct if one is aware of the well known land building succeession going on there. Mangroves occur naturally in the wide tidal mouth of rivers called estuaries *Rhizophora* regenerates itself along the water front by dropping viviparous seedlings They wi'l root only in water of more than certain depth (25 cm). The dense tangle of stilt roots of the spp. facilitates collection of mud and the floor is raised. *Avicennia* which can regenerate at lesser depth (less than 25 cm) appears on the raised flats, *Rhizophora* gradually getting eliminated. It is pushed out of its original place to the water front where conditions are favourable for its rcgeneration. Similar changes in the habitat away from water front, semi-fluid mud to salt marshes then to interior drier marshes then fresh water conditions with corresponding changes in vegetation leading to the local climatic climax are noticed. From this it is clear that mangrove forests are unquestionably seral. Neither of the climax theories adequately explains it. But if the entire mangrove vegetation is viewed as a pattern of populations corresponding to the pattern of environmental gradients, occurring as a partially stabilised 'steady state' the theory of climax pattern fits the case in point.

The question of taking a definite stand on any one of the theories mentioned above is not possible for want of detailed ecological studies on successional patterns for this country. Nor is such a decision found necessary for classifying forest types from practical utility point of view. However Champion inclines to the view that the theory of climax parterns provides the most acceptable frame work for classifying the vegetation, This was given sufficient importance in the present revised classification of the Indian forest types.

CONCEPT OF FOREST TYPE

The definition of forest type as given in this monograph, " A revised Survey Of the Forest Types Of India" is reproduced and explained below. '............. a forest type may be defined as a unit of vegetation which possesses (broad) characteristics in physiognomy and structure sufficiently pronounced to permit of its differentiation from other such units. This is irrespective of physiographic, edaphic or biotic factors. It is selected in the first place subjectively from the ever-varying cover of vegetation, with boundaries arbitrarily imposed on what are in fact gradual changes (clines or continua)" Elaborated it means as follows. It is a unit of vegetation having main distinctive features, physiognomic and structural, strongly marked as to distinguish itself from other such units. For this purpose the vegetation present at the time being only is considered without taking into account

the influence of physiographic, edaphic and biotic factors upon it. It follows that forest communities with unlike site factors are grouped under the same type so long their physiognomy and structure are similar. Selection of types in the field is purely a matter of observation based on the dominants namely trees for our purposes and so bound to be subjective. When forest vegetation occurs continuously over a fairly large area with gradients in ecological conditions continuous (gradual) variations in vegetation correlated with ecologicol gradients are noticed. This sequence of communities showing gradual changes in composition (and sometimes structure) over distance in major vegetation type is termed cline or continum. To delimit types out of a cline is often difficult and remains mostly a matter of opinion, guided by considerations of convenience and usefulness.

The concept of forest type is based upon knowledge of a series of separate individual communities which are more or less similar

For the purpose of this monograph, of the main recognizable forest types those that are widespread " on sites and soils of medium depth and fertility " are referred to as climatic climaxes" and those which are

" clearly associated with definite site factor and differ appreciably from the prevalent type of the surrounding area " as edaphic climaxes ". The term site factor is taken to mean the combined effect of the site caused by microtopographic, micro-climatic or moisture and drainage factors". The climatic and edaphic climaxes recognised in the monograph are denoted by letters C & E respectively.

Besides climaxes. vegetation also exists as unstable communities at certain stages in a particular succession or sere which may be primary or secondary. primary sere are those which have their origin on ground not previously occupied by vegetation. A new sere beginning after the succession has been stopped by the destruction of some latter phasc, as when tree dominants of a forest are fellled is called a secondary sere. The primary and secondary seres are recognited as IS and 2S respectively.

Forests whether of climax or seral stage, in a heavily populated country like ours, have not escaped the influence of biotic factors particularly " excessive grazing, lopping for fodder. green manure or fuel and unregulated felling for timber, poles and fuel".

The operation of these factors is highly selective and species useful for several purposes have suffered the worst. The composition of the vegetation after recovery depended upon the relative hardiness and recouping capacity of the species. Large degraded areas occur along with many of the climax types. They have come to stay as a distant part of the Indian forest vegetation. They are recognised and described as " Degradation Stages" or " DS".

3

CLASSIFICATION OF VEGETATION TYPES

Need for Classification

A good knowledge of forest type is essential for the successful practice of silviculture and forest management which are forms of applied ecology. Forest ecological study aims to obtain an understanding of the structure and interrelationship of forest types, their origin, development and response to varying intensities of different factors. and identification of seral and climax stages. With this in view the types are investigated for their characteristics, described for purpose of comparision and classified to produee a system to fit in great number of details. Data regarding characteristics of types can be collected under any of the categories viz. physiognomy, structure, function, dynamics, floristics etc. Description helps to recognize similarities and dissimilarities by comparision. A classification of data enables to grasp the complexity of details of numerous, types and enhances understanding of forest vegetation.

An admirable account of the highly personal nature of the work involved and the great talents called for with regard to vegetational studies reproduced below gives an idea of the magnitude of the task "........... vegetation analysis and has usually been done especially in the past, by botanists thoroughly trained in taxonomy and often widely travelled in their own countries and the world. On the basis of their observation, sharpened by long experience they have judged the relative abundance of species, their relative dominance in their respective communities, their ecological amplitudes, their dynamic behaviour, their relative exclusiveness to certain situations or associations etc, They have observed the combinations of species; often in correlation with rather obvious natural situations or habitats that formed obvious communities which recovered in suitable places over a more or less wide territory. Both the grosser aspects of physiognomy and some of its more subtle expressions have been perceived", "........... the ecologist or plant geographer makes a rather subjective and intuitional integration of a myraid of factors to arrive at a conclusion that seems to fit the situation —to describe it, to give it a conceptional frame work to organise and classify it", (Manual of Vegetation Analysis by Cain & Castro-1959) Vegetational studies in capable hand 'whose comprehension of plants and the other contributory science in the field of vegetation has been sufficient, whose experience has been broad and deep enough, whose observations have been astute enough' could rise to the level of art.

The most important purpose a classification serves is being a standard of reference. This is specially so in the field of forestry. Particular silvicultural and management practices are devised for particular forest types and a "system of classification of forest vegetation makes it possible to apply and evolve these practices in a controlled scientific manner".

Unit of Description

For the purposes of description species is regarded as a basic unit in floristic classification. For the study of vegetation, although there is no such definable unit, ecologists treat association, floristically defined sub-division of formation as somewhat equivalent to species.

Approaches to the study of vegetation

There are two approaches to the study of vegetation. One is by grouping communities into progressively more inclusive groups on the basis of *similarities* on the lines species, genera; families, etc. are formed. It starts at the bottom with the taxonomy of small units and builds up; it is a *synthetic* approch Such an approach is possible only after a detailed investigation of association and admirable accounts are available for European vegetation. The other approach is to start with broad formation and breaking them down into constituent units namely assosiation on the

basis of *dissimilarities*. This is an *analytical* method. But our present knowledge of plant associations is " far too incomplete to make the first method generally applicable" and this likely to hold up progress for a long time. Under the second method some form of classificarion is possible even with the present limited knowledge.

CLASSIFICATION OF TYPES

The classification of vegetation types varies with the purpose and accordingly the criteria used are also different. The criteria may be properties of vegetation itself or climate of properties of vegetation - environment complex called eco-system.

Classifications based mainly on vegetation

The classification based on the properties of vegetation may be essentially physiognomic or floristic.

Beards's Classification (1955)

Beard's classification of climax vegetation in America belong to the first group. The classification begins with floristic groups or associations *(Schima-Bauhinia)*. Floristically different associations may show strong physiognomic similarities on account of similar habitats in which they

occur and they are clubbed together in physiognomic categories known as formation (deciduous seasonal forest). The formations are arranged in a small number of formation series on the basis of closely related series of habitats. In this classification vegetation is primary while considerations of micro - environment and succession and climax are secondary.

Fosber's Classification (1958)

Fosber's classification of the vegetation of humid tropics is physiognomic like the one above but differs in its being analytical. It commences with the primary " great structural group "based on spacing. It descends to formation class" (forest scrub etc. " formation group" (evergreen, deciduous etc.) formation" (rain forest, etc.) and ultimately "sub-formation (mesophyll, megaphyll etc). It serves well for descriptive purposes but does not show clearly the relationship between climax and its derivatives and arrested development due to fire etc.

Aubreville's Classification

Aubreville justifies physiognomic approch. According to him " a climatic formation is a physiognomic and biological unity, a collection of many associations, and reflects the condition of the habitat. In an area, however large, where the environmental conditions are the same there will usually be a single formation, within which there will be numerous associations of species determined by

hazards of past migration, evolution and survival. The associations will vary in space and in time according to the chances of competition, but while the habitat remains unchanged, the vegetation type remains Thus, the climatic formation is a true reflection of climate". He views secondary formation not ordinarily in stable equilibrium with the regional climates, are maintained by biotic factors like fire (Dry savannah woodland of Africa). He treats these biotically controlled formations as degraded formations. His main divisions are formation types and subdivides each into climatic edaphic and degraded formations.

Braun-Blanquet System

Braun-Blanquet system followed in Europe is fioristic He says "The preliminary arrangement of associations acccording to their appearance is an expression of laziness without philosophic grounds". He rejects the concept of physiognomy and subordinate considerations of succession. He begins wtih the grouping of species in plant associations and proceeds with higher units, alliances, orders and classes which may or may not coincide with phosiognomic plant formations.

Classification Based mainly on Climate

Schimper's Classification (1898)

Schimper divided vegetation into tropical, temperate and arctic types corresponding to zones of temperature

limited by latitudes. As altitude also influences temperature suitable altitudinal belts for hills similar to that of latitudes formed. Three main climatic formation types namely *Woodland, Grassland* and *Desert* were distinguished in each zone or belt The formation types are divided into *climatic* and *edaphic* formations. Tropical vegetation of his classification was arranged in a series on the basis of decreasing favourable moisture conditions, *viz. Rain forest Monsoon forest Savannah, Thorn, Tropical grassland* and *Tropical desert.*

The earlier system of classification based either on temperature along (tropical, subtropical, temperate and alphine regions) or rainfall (equatorial, tropical (marinel tropical, (continental) and desert) were to generalised to be of use for precise study. Later the practice is to define climatic types in statistical terms in which the climate as a geographical factor, is to be regarded as having definite and uniform characteristic. A number of empirical, formulas and symbols were employed and indices of climate worked out. Classification have been put forward from time to time and some of them are given below.

In his study of climate and vegetation Koppen (1931) distinguished eleven main climatic zones on temperature (temperature of the hottest and coldest month and rainfall (relative rainfall of the wettest and driest months) and the seasonal distribution of rainfall. The chief climatic factors are given in symbols and combined into a climatic formula.

This classification is, however, based more on reactions of vegetation with climate than on metrological data. When applied to India with a uniform temperature regime (mean annual temperature over the whole of the country exceeding 24°C except in the hilly areas and the extreme north-west). 'Koppen's system is unnecessarily difficult and complicated". It is unsystematic because of the large number of symbols which are difficult to remember.

Precipitation Effectiveness Index (1931)

Thornthwaite evolved a formula for calculating a Precipitation Effective (P. E) Index in terms of temperature at which the rain fell. It is based on the Precipitation, Evaporation Ratio, (total monthly precipta-tion divided by the total monthly evaporation). This index with a range serves as a basis for differentiation vegetation types on physiognomy (Rain forest 128 and above, Forest 64 to 127, Grassland 32 to 63, Steppe 16 to 31 and Desert less than 16). Variations in seasonal distribution of the rainfall in relation to temperature and growing season are taken into account. According to him there will be fifty vegetation types for given conditions of temperature, P. E. and sessonal distribution of rainfall. When applied to the Indian vegetation it " did not fit very well " with what actually existed.

Temperature Efficiency Index (1933)

Thornthwaite differentiated thermal zones on the basis of temperature efficiency. Ah index for each month by the

formula $\frac{1}{4}$ (TF°—32) is worked out aud indices for twelve month so obtained are summed up which will give an index with numerical values ranging from 0 to 128 and over. They are classified in geometrical progression.

Temperature province	T-E index
A. Tropical	128 and above
B. Mesothermal	64-127
C. Microthermal	32-63
D. Taiga	16-31
E. Tundra	1-15
F. Forest	0

A map was prepared and according to this classification the whole of the Indian peninsula and plains are tropical. The thermal efficiency zonation does not agree with the vegetation actually present. Classification cannot be done on the basis of thermal efficiency alone.

Potential Evapotranspiration (PE) (1948)

It is a thermal regime developed by Thornthwaite. It takes into account the role of moisture stored in the soil and the energy relations involved in both evapotation and transpiration. It is defined as the combined evaporation and transpiration which would occur from a vegetation covered

surface if soil moisture conditions were adequate for unrestricted transpiration. This is computed from the monthly temperature and precipitation records and from latitude. When compared with the precipitation and allowance made for the storage of water in the ground and its subsequent use, periods of moisture deficieney (d) and surplus (s) are clearly revealed. Values for PE. d and s for each month are worked out and from this annual values are obtained From the relationship of the annual values of water surplus (s) and water deficit (d) and PE a moisture index is prepared from an empirical formula. On the basis of this index the world is divided into moisture provinces ranging from Arid to Perhumid.

When the climatic types of India were worked out according to this classification it was found to be good enough for broad generalisation of types. Within these types the actual climatic characteristics of certain localities did not conform to the over-all type, e. g. Hydrabad included in sub-humid with moderate summer water surplus type. In involves complicated calculations and therefore cumbersome. Inspite of these shortcomings, it is found to be better than others in the interpretation of the distribution of vegetation types of India.

Shanbhag (1958) has evolved a system of *Effective Growth Index* for differentiating humid and arid climates. This system is based on the thermodynamic principle that

the velocity of any chemical reaction doubles or trebles with each rise in temperature of 10°C. This is further linked with the fact that up 30°F the growth stimulating factors are dominant and beyond that limit the inhibiting factors come more into play. The computed effective growth indices were plotted on a map and through the study of vegetation soil and landscape a range of Effective Growth Indices were obtained. They are correlated to climates like arid. semi-arid etc. The map prepared accordingly shows the limit of dry climatic zones " more or less satisfactorily ".

Paterson's Climate - Vegetation - Productivity Index (1956)

Paterson made a recent attempt to compare the timber productivity under different climatic conditions. He evolved a *Climate - Vegetation - Productivity Index* based on the temperature of the warmest month, the annual range of temperature, the annual precipitation, the number of months in the growing season' and the solar radiation received. Climatic-isophytes (lines joining points of equal productivity were prepared and they agreed with the limits of arid, dry and moist forests. This is particularly so in the delimiting stablished forest types like Thorn forest, Dry and Moist Teak, Moist Peninsular Sal etc.

Although climate exercises the predominant control over major vegetational areas its development is also

influenced by other factors like the availability of species, their special adaptations, the interactions between plant life and environment etc. So a system of classification based on climate alone may not be adequate to explain fully the distribution of vegetational types.

Classifications Based Mainly on Eco-System

Eco - System

The term eco-system means a group of interdependent plants and animals forming a complete single unit (community) together with all the influences of the environment. It takes into account all living things, micro-organisms (soil fauna, fungi, bacteria, etc.) and animals like worms, insects, birds. etc. and vegetation from ground flora to trees; and all factors of habitat namely, temperature, rainfall, light, humidity, soilair, soil solution etc. Each one of these factors does contribute to the whole complex. Complete understanding of an eco-system means a multi-dimensional study and involves a very elaborate investigation It is an ideal which is scarcely attainable.

Classifications on this basis are few and they take into account only the broad features of mature eco-systems. Some of the important classifications are those by Burtt-Davy, Swain, etc. The present classification by Champion and Seth as well as its original belong to this group.

Burt-Davy synthesised a system out of the classifications of Schimper and Warming for tropics, Chipp, Champion, Clements and out of his own long experience of African vegetation. The main units are formation types defined on physiognomy and named after the dominant life forms (Woodland, Grassland, and Desert) The formation are broadly grouped into moist and dry on the availability of moisture. Climatic and edaphic climaxes are distinguished. While applying this system to India there arises the difficulty " to co-ordinate the extensive open grassy savannah types of Africa with their counterpart in Asia". It could approximate only to the Tropical Dry Deciduous of Champion's Classification. This classification does not recognise any temperate vegetation in the tropics.

Swain's (1938) classification evolved for Australian vegetation does not seem to fit completely with vegetational areas of other regions.

Champion's original classification " A preliminary Survey of the Forest Types of India and Burma" was first published in 1935. Nearly twenty five years after, in 1961—'62 this was revised by Champion and Seth. The new classification "A Revised Survey of the Forest Types of India" includes all types in all the States, Andamans and one corner of N. E. F. A., and excludes those of Burma.

The present classification retains the frame work of the original classification. The significant change made is the grouping of all types " associated with sites in which the soil is subject to excessive wetness either continuously or for periods long enough to have a marked effect on the vegetation under " Littoral and Swamp Forests". Formerly there were dealt with as stages in primary seres under the concerned types. The ecological status of all types in the light of biotic influences were critically examined and as a result types formerly ranked as climax have been placed as stages in secondary seres or degradation stages.

The classification has been formed with practical utility in mind and as a workable system for practising forester and research worker. Although it is an improvement over its original with regard to additional information and presentation it is still a " provisional scheme" due to lack of detailed study and consequently much less advance in our knowledge.

GLOSSARY

Alkali Soil :

Generally a highly alkaline soil. Specifically an alkali soil has so high a degree of alkalinity PH 8.5 or higher or so high a % of exchangeable sodium or both that the growth of most plants is reduced. Cf. Exchangeable sodium.

Associations :

(Fairly well defined) smaller units of climax formation with more than one dominant species.

Basalt :

A dark coloured igneous rock of which there is a large number of types, formed by the solidification of lava.

Base .

A substance which dissolves in water with the formation of hydroxyl ions.

Conglomerate

A rock composed of rounded fragments grading from gravel to pebble in size cemented together in a matrix of finer material (often sandy)

Consociation :

(Fairly well defined) smaller units of climax formation with one dominant species.

Creek ;

A narrow coastal inlet.

Crystalline rock :

Rocks wholly or chiefly of mineral crystals.

Dominant species :

Cotrolling species giving characteristic appearance to the vegetation. Strongly influence and sometimes largely determine the rest of the species of an association particularly by shading.

Efflorescence :

Formation of fluffy greyish white salts in saline and alkaline soils in dry season,

Exchangeable sodium :

Sodium that is attached to the surface of soil particles which can be exchanged with other positively charged ions in the soil solution such as calcium and magnesium.

Gneiss :

A metamorphic rock of coarse grain size characterised by a mineral banding, in which the light minerals (quartz and feldspar) are separated from the dark ones (mica and / ore hornblende) Cf. Metamorphic rock.

Granite :

Coarse-grained igneous rock which always contain quartz and feldspar as well as other minerals. So coarse in structure that the different mineral grains can be plainly seen. One of the hardest and most durable and most abundant rocks. Cf. igneous rock

Immature soil :

A soil lacking clear individual horizons because of the relatively short time for soil building forces to act upon the parent material since its deposition or exposure.

In situ :

(in place) Formed or accumulated on the spot. A rock may decay and breakdown into small particles where it is first exposed in the land surface. It is then said to have weathered in place or *in situ*.

Kaolinite :

A finely crystalline form of hydrated aluminium silicate. (OH) $4Al_2$ Si_2 O_5 occuring as minute flaky crystals.

Laterite rocks :

They are composed of cellular reddish ferruginous clay formed under damp tropical conditions as a result of subserial decomposition of basalt, trap or granite rocks, soft becomes hard on exposture, brown red with yellow spots, vesicular and rough to feel and composed of clay mixed with hydroxides of aluminium and iron ; the soil as a result of leaching is infertile.

Leaching :

The process by which material such as organic and mineral salts is washed out of a layer of soil into a lower layer by percolating rain water.

Littoral :

Of the seashore, the strip of land along a sea coast.

Massif :

Mountain heights forming a compact group.

Metamorphic rock :

Rocks derived from igneous or sedimentary rock by mineralogical, structural and chemical alterations due to heat (which sometimes causes the minerals to recrystallize) or pressure (which alters the rock structure) or water action which dissolves some rock material and deposits other materials for eg. Granite is an equivalent of gneiss. limestone or marble, shale or slate.

Out crop :

The portion of a rock stratum which projects above the earths surface and is thus exposed to view.

Pan :

A layer of soil harizon within a soil that is firmly compacted by iron hydroxides, organic material, silica, lime etc.

Peat :

Unconsolidated soil materials consisting largely of undecomposed or only slightly decomposed organic matter accumulated under conditions of excessive moisture in cold and temperate regions·

Plateau ;

An extensive, level or mainly level area of elevated land.

Preclimax :

A community found on less favourable moisture conditions than prevailing generally in an area.

Physiologically dry :

The condition when a plant is unable to take in water because of low temperature or because the water available to it contains substances in solution which hinders absorption by the plant.

Post climax :

A community occurring on more favourable moisture condiions than prevail generally in an area,

Predominant :

Term refers to abundance and corresponding importance of species.

Quartzite :

An extremely hard, resistant rock, formed from sand stones by the filling of the pore spaces with quartz.

Relief :

Elevations of the land surface, considered collectively.

Retrogression :

A step from superior to inferior type in plant community.

Riperian :

Growing on the banks of river and steam.

Rock .

An aggregate of mineral particle forming part of the earth's crest.

Saline soil :

A soil containing enough soluble salts (sodium chloride, calcium sulphale) to inpair its productivity for plants but not an exces of exchangeable sodium.

Sandstone :

Compacted and cemented sedimentary rocks, which consist essentially of rounded grains of quartz, between the diameters of 1 mm. and 0.1 mm· with variable content of heavy mineral grains.

Sedimentary rock:

Rocks which have been deposited as beds often as sediments (ie. under water). They were laid down in distinct layers or strata separated by bedding planes. Common forms of sedimentary rocks are sandstone, shale, limestone and conglomerate.

Sesqui :

Containing two kinds of radicals (groups of atoms) in the proportion 2 : 3 which pass unchanged through a series of reactions, but is normally incapable of separate existence.

Shale :

A consolidated clay rock which possesses definite amination.

Silica - sesqui oxides :

The ratio of the number of molecules of silica to the number of molecules of alumina plus iron oxide in a soil or the clay fraction of a soil. The more highly weathered materials of warm-temperate humid regions and especially of the tropical generally have low ratios.

Tidal :

Of the ground subjected to ebbing and flowing of tides,

Traprock :

They are of volcanic origin, full of cavities and vesicles containing same minerals as basalt rock but less deeply coloured. Their outcrops give rise to a teraced type of scenery.

Usar :

A local name for saline-alkali soil.

Viviparous :

Said of a seed which begins to germinate before it is detached from the parent plant

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4

THE REVISED CLASSIFICATION

Major groups, Type groups, Types

In the present monograph forest vegetation is divided into five *major groups* according to temperature zones namely Tropical forests, Montane subtropical forests, Montane temperate forests, Subalpine forests and Alpine scrub. Each major group is subdivided into *type groups* on the availability of moisture exhibited in the physiognomic variation like evergreen, deciduous, thorny features etc. The type groups are ultimately distinguished into *climatic, edaphic seral* and *degradation types* on floristic and physiognomic and geographic basis. There are southern and northern forms (subgroups) of the type groups. The difference is mostly floristic and this is more pronounced in the moister types There are sixteen type groups which are serially numbered and the southern and northern subgroups are denoted by letters A & B respectively. Subtypes are shown by letters a, b, c etc, The ecological status of the type is indicated by letters C for climatic climax, E for edaphic climax, IS for primary seer and 2S for secondary seer and DS for degradation stage. For each type a general description of the forest and the

locality factors, plant lists (Floristics*) for typical examples and ecological notes are given. By way of illustration following is reproduced from the revised classification.

Major group
Tropical forests

Type group - 2
Tropical semi - evergreen forests.

Subgroup 2A
Southern tropical semi - evergreen forests

Types
C1 Andamans semi - evergreen forest
C2 West coast semi - evergreen forest
....

* The following floristic groups usually differentiated and other abbreviations are given below :

I	Top canopy trees	IV b	Grasses
II	Second storey trees	V	Climbers
II a	Bamboos	Epi.	Epiphytes
III	Shrubs	Par.	Parasites
IV a	Herbs		

Asterisk * against a plant implies that the species is particularly characteristic of the type.

Abbreviations

E	Evergreen	(r)	rare
D	Deciduous	(la)	locally abundant
(va)	very abundant	(lc)	locally common
(a)	abundant	S. P.	Sample plot
(f)	frequent	P. P.	Preservation plot
(c)	common	L.I.P.	Linear increment plot
(o)	occasional		

Subgroup 2B

Northern tropical semi - evergreen forest

Types

C 1 Assam valley semi - evergreen forest

1 a Assam alluvial plains semi - evergreen forest

1 b Eastern submontane semi – evergreen forest

1 S Sub-Himalayan light alluvial semi - evergreen forest

....

Naming the Types

While naming the types terms involving the use of many words implying site conditions have been avoided as far as possible. Prefixes like wet, moist, dry, conveying moisture conditions are preferred. In the case of edaphic types *(*saline/alkaline scrub savannah*)* long terms are unavoidable. Taxonomic terms for naming types have been excluded wherever possible. Where simple morphological terms are found inadequate for certain characteristic physiognomy as in the case of bamboos, palms etc taxonomic terms are used. Subtypes and lower ranks are more freely named after the names of family, genus or species of the conspicuous dominants. (*Mesua* forest, pine forest etc.) If the subtype is an association (2 or more dominants) it is named by two or more dominant genera (Submontane semi - evergreen forest *Schima - Bauhinia*) Terms implying name of locality (Tirunelveli semi - evergreen) name of physiographic

division (Moist peninsular sal; Eastern bhabar sal, kind of soil (Lateritic semi - evergreen), soil conditions (Littoral swamp, Tidal swamp, Riperian) degradation stages are also used.

MAJOR FOREST GROUPS

Tropical Forests

There are seven type of groups viz, 1. Wet evergreen forests 2. Semi - evergreen forests 3. Moist deciduous forests 4. Littoral and Swamp forest 5. Dry deciduous forests 6. Thorn forest and 7. Dry evergreen forests. Except the fourth and the seventh all have southern and northern subgroups, The group Littoral and Swamp forests comprises types determined by special site factors. Although it is desirable ecologically to treat them under respective climate types as successional stages they are grouped under one category for convenience of treatment. The " Dry evergreen forests" is restricted to S. E. of the peninsula.

Montane Subtropical Forests

They occur in hilly tracts and mostly confined to the Himalayas. The chirpine belt of the West and the Central Himalayas, the dry ever-green forest of the plains and low hills of the N. W. are characteristic subtropical forests. It occurs although not so well defined between the tropical vegetation and temperate oak forests of the Eastern Himalayas. In the south Indian hills there is no characteristic subtropical fiora. It is only " an overlap

of predominantly tropical and predominantly temperate floras ". The three main type groups are 1. Subtropical broadleaved hill forests, 2. Subtropical pine forest and 3. Subtropical dry evergreen forests. The first type group alone has the southern and northern forms. Degradation stages are more common than seral ones.

Montane Temperate Forests

They occur only in the higher hills. They are distinguished into 1. Montane wet temperate forests 2. Himalayan moist temperate forests. The southern form of the first type group is restricted to S. Indian hills from about 11 500 m. upwards and the northern form in the E. Himalayan from E. Nepal eastwards from 1800 to 3000 m. The Himalayan moist temperate forest occur all along between the subtropical pine forests and subalpine formation with rainfall between 400 and 2500 mm. The last one occurs in the inner ranges of the Himalayas (Kashmir, inner Garhwal).

Subalpine and alpine scrub are confined to higher altitudes in the Himalayas.

Revised Classification of Indian Forest Types

1—MOIST TROPICAL FORESTS

GROUP I—TROPICAL WET EVERGREEN FOREST

PAGE

Subgroup I A. Southern tropical wet evergreen forests 93

C1 (Giant evergreen forests) 106
C2 Andamans tropical evergreen forest 107
E1 (Andamans moist deciduous forest 108
C3 Sothern hill top tropical evergreen forest 109
C4 West Coast tropical evergreen forest 111

Subgroup I B. Northern tropicl wet evergreen forests

C1 Assam Valley tropical wet evergreen forest
(Dipterocarpus)
C2 Upper Assam Valley tropical evergreen forest
(a) *Kayea* forest
(b) *Mesua* forest
C3 Cachar tropical evergreen forest

Geneal Edaphic and Seral types of wet evergreen forests

E1 Cane brakes
E2 Wet bamboo brakes
2I Pioneer Euphobiaceous scrub

PAGE

GROUP 2 — TROPICAL SEMI-EVERGREEN FORESTS

Snbgroup 2A. Southern tropical semi-evergreen forests 130

C1 Andamans semi-evergreen forest 137
C2 West Coast semi evergreen forest 128
C3 Tirunelveli semi - evergreen forests 141
2SI West Coast secondary evergreen *Dipterocarp* forest 142

Subgroup 2B. Northen tropical semi-evergreen forests

C1 Assam Valley semi-evergreen forest
Ia Assam alluvial plains semi-evergreen forest
Ib Eastern submontane semi-evergreen forest
ISI Sub-Himalayan light alluvial semi-evergreen forest
IS2 *Syzygium* parkland
2SI (Pioneer Euphorbiaceous scrub)
2S2 Eastern alluvial secondary semi-evergreen forest
2S3 Sub-Himalayan secondary wet mixed forest
C2 Cachar semi-evergreen forest
C3 Orissa semi evergreen forest

General edaphic and seral types of semi-evergreen forests

E1 (Cane brakes)
E2 (Wet bamboo brakes)
E3 Moist bamboo brakes
E4 Lateritic semi-evergreen forest
2S1 Secondary moist bamboo brakes

PAGE

GROP 3-TROPICAL MOIST DECIDOUS FORESTS

Subgroup 3A. Andamans moist deciduous forests

C1 Andamans most deciduous forest 147
2S1 Andamans secondary moist deciduous forest 149

Subgroup 3B. South Indian moist deciduous forests 151

C1 Moist teak-bearing forests 169
1a Very moist teak forest 170
1b Moist teak forest 175
1c Slightly moist teak forest 178
C2 Southern moist mixed deciduous forest 181
2S1 Southern secondary moist mixed deciduous forest 184

Subgroup C. North Indian moist deciduous forests

C1 Very moist sal-bearing forest
1a Eastern hill sal forest
(i) Eastern hill sal forest
(ii) Khasi hill sal
1b Eastern *bhabar* sal forest
(i) East Himalayan upper *bhabar* sal
(ii) East Himalayan lower *bhabar* sal
C1c Eastern *tarai* sal forest
1d Peninsular (coastal) sal forest
C2 Moist sal-bearing forest

PAGE

2a Moist Siwalik sal forest

2b Moist *bhabar* sal forest

(i) *Bhabar-dun* seai

(ii) *Damar* sal

2c Moist *tarai* sal forest

2d Moist plains sal forest

(i) Western light alluvium plains sal

(i) App. *Chandar* sal

(ii) Eastern heavy alluvium plains sal

(ii) App. Kamrup sal

2e Moist peninsular sal forest

(i) Moist peninsular high level sal

(ii) Moist peninsular low level sal

(iii) Moist peninsular vally sal

DSI Moist sal savannah

C3 Moist mixed deciduous forest (without sail)

3a West Gangetic moist mixed deciduous forest

3b East Himalayan moist mixed deciduous forest

2S1 Northern secondary moist mixed deciduous forests

2S2 (Secondary Euphorbiaceous scrub)

General Edabic and Saral types of moist deciduous forests

El *Terminalia tomentosa* forest

lSl Low alluvial savannah wood-land (*Bombax-Albizzia*)

PAGE

1S2 Eastern hollock forests (*Terminalia-myriocarpa*)
2a *Terminalia-Lagerstroemia*
2b *Terminalia-Duabanga*
2S1 (Dry bamboo brakes)

GROUP 4 — LITTORAL AND SWAMP FORESTS

Subgroup 4A Littoral forests 190

L1 Littoral forests 198

Subgroup 4B. Tidal swamp forests

TS1 Mangrove scrub 209
TS2 Mangrove forest 210
TS3 Saltwater mixed forest (*Heritiera*) 212
TS4 Brakish water mixed forest (*Heritiera*) 212
E1 Plam swamp 213

Subgroup 4C. Tropical freshwater swamp forests 214

FS *Myristica* swamp forest 214
FS2 Submontane hill valley swamp forest 215
FS3 Creeper swamp forest

Subgroup 4D. Tropical seasonal swamp forests

SS1 Eastern seasonable swampforest
SS2 *Barringtonia* swamp forest
SS3 *Syzygium cumini* swamp low forest
SS4 Eastern seasonal swamp low forest (*Cephalanthus*)
SS5 Eastern *Dillenia* swamp forest

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2Sl (*Sezygium* parkland)

2S2 (Eastern wet alluvial grassland)

Subgroup 4E. Tropical riparian fringing forests

RSI Riparian fringing forest 216

II — DRY TROPICAL FORESTS

GROUP 3-TROPICAL DRY DECIDUOUS FORESTS

Subgroup 5A Southern tropical dry deciduous forests

Cl Dry teak- bearing forests 234

la Very dry teak forest 235

lb Dry teak forest 236

C2 Dry red sanders-bearing forest 242

C3 Southern dry mixed deciduous forest 243

Subgroup 5B. Northern tropical dry deciduous forests

Cl Dry sal bearing forests

la Dry Siwalik sal forest

lb Dry plains sal forest

lc Dry penninsular sal forest

C2 Northern dry mixed deciduous forest

Degradation stage of tropical dry deciduous forests

DS1 Dry deciduous scrub 250

DS2 Dry savannah forest 253

DS3 (*Euphorbia* scrub) 255

DS4 (Dry grassland) 256

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General edaphic types of dry deciduous forests

El	*Anogeissus pendula* forest	258
DSI	*Anogeissus pendula* scrub	259
E2	*Boswellia* forest	259
E3	*Babul* forest	262
E4	*Hardwickia* forest	263
E5	*Butea* forest	265
E6	*Aegle* forest	266
E7	Laterite thorn forest	267
E8	Saline/alkaline scrub savannah	268
8a	*Phoneix* savannah	269
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8c	*Salvadora* -*Tamarix* scrub	270
E9	Dry bamboo brake	271

General serial types of dry deciduous forests

ISI	Dry tropical riverain forest	272
IS2	*Khair–sissu* forest	273
IS3	Inundation *babul* forest	274
2S1	Secondary dry deciduous forest	275

GROUP 6—TROPICAL THORN FORESTS

Subgroup 6A. Southern tropical thorn forests

Cl	Southern thorn forest	288
C2	Karnatak unbrella thorn forest	291
DSl	Southern thorn scrub	292
DS2	Southern *Euphorbia* scrub	293

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Subgroup 6B Northern tropical thorn forests

C1 Desert thorn forest
C2 Ravine thorn forest
DS1 *Zizyphus* scrub
DS2 Tropical *Euphorbia* scrub

General edaphic degraded and seral types of thorn forests

E1 (*Euphorbia* scrub)
E2 *Acacia senegal* forest
E3 *Rann* saline thorn forest
E4 *Salvadora* scrub
DS1 *Cassia auriculata* scrub
IS1 Desert dune scrub

GROUP — TROPICAL DRY EVERGREEN FOREST

C1 Tropical dry ever green forest 295
DS1 Tropical dry evergreen scrub 304

III - MONTANE SUB-TROPICAL FORESTS

GROUP 8 — SUBTROPICAL BROAD LEAVED HILL FOREST

Subgroup 8A. Southern tropical broadleaved hill forests

C1 Nilgiri subtropical hill forest 313
DS1 South Indian tropical hill savannah woodland 311
E1 Reed brakes *(Ochlandra)* 316
C2 Western subtropical hill forest 318

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C3 Central Indian subtropical hill forest 320

DS (Degradation stages of Southern sub tropical) broadleaved hill forests) 323

Subgroup 8B Northern Subtropical broadleaved wet hill forests

C1 East Himalayan subtropical wet hill forest

C2 *Khasi* subtropical wet hill forest

2SI (Assam subtropical pine forest

DSI (Assam subtropical hill savannah woodland)

GROUP 9 — SUBTROPICAL PINE FORESTS

C1 Himalayan subtropical pine forest

la Lower or Siwalik chir pine forest

lb Upper or Himalayan chir pine forest

DSI Himalayan subtropical scrub

DS2 Subtropical *Euphorbia* scrub

C2 Assam subtropical pine forest

DSI Assam subtropical pine savannah

GROUP 10—SUBTROPICAL DRY EVERGREEN FORESTS

C1 Subtropical dryevergreen forest

la *Olea cuspidata* scrub

lb *Acacia modesta* scrub forest

DSI *Dodonaea* scrub

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IV — MONTANE TEMPERATE FORESTS

GROUP II — MONTANE WET TEMPERATE FORESTS

Subgroup I I A Southern montane wet temperate forests

C1 Southern montane wet temperate forest 325
DSI Southern montane wet scrub 334
DS2 Southern montane wet grassland 335

Subgroup I I B Northern montane wet temperate forests

C1 East Himalayan wet temperate forests
1a Lauraceous forest
1b Buk oak forest
1c High-level oak forests
C2 Naga hills wet temperate forests

GROUP — HIMALAYAN MOIST TEMPERATE FORESTS

CI Lower Western Himalayan temperate forests
1a *Ban* oak forest (Q. *incana)*
1b *Moru* oak forest (Q *dilatata*)
DSI Oak scrub
1c Moist deodar forest (*Cedrus*)
1d Western mixed coniferous forest (spruce, blue pine, silver fir)
1f (Low-level blue pine forest (*P. wallichiana)*
DSI Oak scrub

PAGE

DS2 Himalayan temperate secondary scrub

C2 Upper West Himalayan temperate forests

2a *Kharsu* oak forest (*Q. semecarpifolia*)

2b West Himalayan upper oak/fir forest

2c (Moist temperate deciduous forest)

C3 East Himalayan moist temperate forest

3a East Himalayan mixed coniferous forest

3b *Abies delavayi* forest

Degradation stages of Himalayan moist temperate forests

DS1 Montane bamboo brakes

DS2 Himalayan temperate park-land

DS3 Himalayan temperate pastures

General edaphic and seral types of Himalayan moist temperate forests

E1 Cypress forest

1S1 Alder forest

1S2 Riverain bule pine forest

2S1 Low-level bule pine forest

GROUP 13 — HIMALAYAN DRY TEMPERATE FORESTS

(i) *Western types*

C1 Dry broadleaved and coniferous forest (*Quercus ilex/P. gerardiana*)

C2 Dry temperate coniferous forest

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2a *Neoza* pine forest *(P. gerardiana)*
2b Dry deodar forest *(Cedrus)*
DS1 *Pohu* scrub
C3 (West Himalayan dry temperate deciduous forest)
C4 West Himalayan high-level dry bule pine forest *(P. wallichiana)*
C5 West Himalayan dry juniper forest (*J. macropoda*)
(ii) *Eastern types*
C6 East Himalayan dry temperate coniferous forest
E1 Larch forest (*L. griffithiana)*
C7 East Himalayan dry juniper/birch forest *(J wallichiana)*

General seral types of temperate forests

1S1 *Hippophae /Myricaria* scrub
1S2 *Populus/Salix* forest
1S3 (Western high-level dry bule pine forest)

V—SUB—ALPINE FORESTS

GROUP 14 — SUB-ALPINE FORESTS

C1 West Himalayan sub-alpine birch/fir forests *(Betula/Abies)*
1a West Himalayan subalpine fir forest
1b West Himalayan subalpine brich/fir forest
C2 East Himalayan sub-alpine birch/fir forest

PAGE

Seral and degraded types of sub-alpine forests

ISI (*Hippophae/Myricaria* brakes
IS2 (Deciduous sub-alpine scrub)
2SI sub-alpine pastures
DSI Sub-alpine pastures

VI—ALPINE SCRUB

GROUP I5 — MOIST ALPINE SCRUB

C1 Birch/*Rhododendron* scrub forest
C2 Deciduous alpine scrub
E1 Dwarf *Rhododendron* scrub
E2 (Dwarf juniper scrub)
C3 (Alpine pastures)

GROUP I6 — DRY ALPINE SCRUB

C1 Dry alpine scrub
E1 Dwarf juniper scrub

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5 DS3	*Euphorbia* scrub	255
5 DS4	Dry grassland	256
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MOIST TROPICAL FORESTS

GROUP I. TROPICAL WET EVERGREEN FORESTS

Sub - group IA. Southern Tropical Wet Eevrgreen Forests

1. NOMENCLATURE

Maharashtra	...	Tropical evergreen rain forest
Mysore Madras Kerala	...	Tropical evergreen (*Shola*)
Andamans	...	(Hill) Everygreen low fores (PARKINSON)

2. GENERAL DESCRIPTION

Lofty, dense, evergreen forests, 45 m. or even more high, charcterised by the large number of species of trees which occur together. Consociations (gregarious dominants) are rarely met with and ordinarily two thirds or more of the upper canopy trees are species individually contributing not more than I per cent of the total number; a few species of the top storey are trees with clear boles 30 m. long and 5m or more in girth, and may be briefly deciduous without effecting the evergreen nature of the forest as a whole. The canopy is extremely dense; it has been demonstrated that apart ftom the scattered giants which project well above the general canopy, differentiation into definite canopy layers probably does not exist (RICHARDS). Epiphytes are numerous, especially ariods, ferns, mosses and orchids. Climbers vary greatly in amount being sometimes conspicuous but often not so;

on the whole they are less characteristic than in the semi evergreen and moist deciduous forests. Gronnd vegetation in typical cases may be almost absent; elsewhere a carpet of *Strobilanthes* or *Selaginella* and fens may occur; grasses are absent. The undergrowth is often tangle of canes, creeping bamboo and palms, which may replace high forest as cane brake along streams. Erect bamboos are unusual, but may occur locally, Long cylindrical boles unusually with thin smooth bark are typical but plank buttresses are also frequently seen. The leaves are thick and glossy, only rarely finely pinnate or hairy, and are very often white are pink when young. Cauliflory may be relatively common.

3. DISTRIBUTION

Throughout the tropical portion of the country wherever the rainfall is adequate and its distribution satisfactory except on precipitous slopes and very rapidly draining soils. Most extensive along the W. Ghats from Tirunelveli nearly up to Bombay; though often only as residual patches especially towards the north.

Maharashtra

Along the W. Ghats nearly from Bombay and southwards.

Mysore, Madras and Kerala

Along the whole length of the W. Ghats through Mysore (Shimoga, Mangalore, Coorg, Wynaad), Palghat, Tirunelveli.

Andamans

On moist loamy hills throughout the Islands.

4· LOCALITY FACTORS

Temperature– The mean temperature of the year is very close to 27°C, and the mean January minimum is always over 18°C and usually about 21°C. Data are given for three fairly representative stations in the following statement.

Temperature Data (centigrade)

Southern tropical wet evergreen forests

Month	Kerala MANGALORE 22 m.			Kerala COCHIN 3 m.			Andaman Islands PORTBLAIR 80 m.		
	Mean	Mean max	Mean max	Mean	Mean max	Mean min	Mean	Mean max	Mean max
Jan.	26 6	31.7	21.4	26.8	30.5	23.1	25.5	29.0	22.0
Feb.	26.8	31.1	22.5	27.4	30.6	24.2	25.6	29.7	21.4
Mar.	26.2	32.0	24.3	28.3	31.3	25 6	26.4	30.8	21.9
April	26.4	32.9	25.8	28 7	31.4	25 9	27.7	31.7	23.7
May	26.3	32.7	26 0	28.3	30.8	25.7	27.2	31.7	23.7
June	26.6	29.2	23.8	26.5	29.0	23.9	26.5	29.1	23.9
July	26.1	28.7	23.5	25.9	28.1	23.7	26.4	28.8	23.9
Aug.	26.2	28.8	23.4	25.9	28.0	23.9	26.2	28.6	23.7
Sept.	26.3	29.1	23.5	26.2	28.3	24.1	25.8	28.4	23.2
Oct.	26.8	29 9	23.7	26.6	29.1	24.1	26.0	28.8	23.2
Nov.	27.1	31 0	23.1	26.9	29.8	24.1	26.0	28.8	23 2
Dec.	26.8	31 7	21.4	26.9	30.3	23.4	25.7	28 7	22.7
M. A. T.	27.2			27.1			26.3		
Annual mean max.	30 7			29.8			29.4		
Highest record	37.8			33.9			36.1		
Annual mean min.	23.6			24.3			23.1		
Lowest record	16.7			17 8			16.7		
No. of years	60			60			60		

Rainfall and Humidity. The annual rainfall is from 2000 mm. upwards, rarely down 1,500 mm. but the type does not spread generally over most sites till 3000 mm. or more is reached. The dry seasons is not usually prolonged, only 2 to 4 months having less than 50mm.; if it is longer as in the northern part of the W.Ghats, the development of the type requires a heavier raiafall and it is restricted to favourable sites but proximity to the coast also exerts favourable influence. This dry season is connected with the monsoon climate and is more marked than usual in this type in other countries. The monthly rainful and annual totals for the same stations are given below :-

RAINFALL (MILLIMETERS)

SOUTHERN TROPICAL WET EVERGREEN FOREST

Month	Kerala MANGALORE 22 m.	Kerala ÇOCHIN 3 m.	Andaman Islands PORTBLAIR 80 m.
January	3	23	45
February	2	20	28
March	5	51	28
April	39	125	60
May	157	297	384
June	942	723	562
July	988	592	392
August	597	353	414
September	266	195	442
October	207	340	318
November	72	170	267
December	13	41	201
Total for year (M.A.R.)	3,292	2,929	3,143
No. of rainy days	118	130	150
No. of months with less than 50 mm.	5	3	3
M. A. Humidity	77	79	81
No. of years	60	60	60

Rock and Soil–The greater part of the tropical wet evergreen forest is found on crystalline rocks, usually gneiss or granite, though it extends over the metamorphi crocks, shales and even limestones and quartzites.

It also extends over alluvial soils in the valleys and notably in the Brahmaputra valley. In the Andaman Island where excessively free draining sandstones predominate, the type tends to be restricted to outcrops of volcanic rocks, moisture receiving sites in the valleys and low lying alluvial deposist near the coast.

The characteristic features of the soil are its highly leached condition involving low base content, a low silica sequioxide ratio, acidic reaction, clay mostly as kaolinite. There is little accumulation of organic matter except locally in wet flats. The mineral nutrient is largely concentrated in the surface layer where it is maintained by the large amount of organic matter doposited by leaffall etc. from the forest. Nutrient circulation is very rapaid and the removal of the forest cover is liable to be quickly followed by a serious and permanent drop in fertility. There is still extremely little known about these soils but a useful summary has recently been published by SETH and YADAV (1960)

Topography-Flat or hilly ground upto 800 m. extending further up valleys to 1,000m. or so (with some variation in floristic composition). Very generally the level ground and lower slopes have been cleared in the past, as along the W. Ghats where the type is absent from the coastal plain, but

comesin at about 500 m. and extends even upto 1,500m, the higher slopes getting more rainfall, and more favourable humidity condition consequent on the lower temperature, Primary climax forest is no longer to be found on the coastal strip, and the soil itself has been degraded by exposure (cf. Type 2A/2SI.)

Light-Practically no information has been collected in India, put in view of the close comparability between Indian tropical evergreen forest and that in other countries, it is probable that similar relationship hold It appears that the light intensity in the undergrowth is generally about 1 % of that prevailing above the top canopy and it is mainly in the red end of the spectrum; during the middle of the day the intensity varies considerably owing to the passage of sun-flecks which may briefly raise it to 10-72% of the intensity in the open. For details, see RICHARDS (1952).

5. GENERAL FLORISTICS

Dipterocarps are very characteristic but not an essential constituent: they are more numerous anb varied in the S.E. nearer the center of distribution of the family, and fewer and less varied, and often locally absent on the West Coast; the most widly distributed genera are *Dipterocarps* and *Hopea*. Other typical components are *Guttifera* (notably *Calophyllum*, *Poeciloneuron*, *Mesua*), *Anacardiacaea*, *Sapotaceae*, *Meliaceae*, *Artocarpus*, *Eugenia* and *Elaeocarpus* whilst *Leguminosae* (*e.g.Kingiodendron*) are relatively uncommon (in contrast with similar forests in other countries). These trees are primarily in the top storey.

In the middle canopy which is almost entirely evergreen the predominant families are *Myrtaceae* and *Lauraceae* but very many others are represented.

Bamboos are relatively rare in the climax type except for such climbing forms as *Dinochola* and locally *Oxytenanthera nigrociliata* in the Andaman Islands and are often absent. Canes are generally abundant especially on wet ground and there are usually erect palms of several genera.

The shruby undergrowth when present consits mainly of *Strobilanthes* and other *Acanthaceae* or of evergreen *Rubiaceae* (*Ixora, Canthium*, etc) but many *Anonaceae* and other families are well represented. Other monocotyledons are generally present.

Climbers are on the whole not heavy but may become so in any openings

6. SUBDIVISIONS, SUCCESSIONS, ETC

The following four types of which the first is some what conjectural are separately described below as also the associated cane and bamboo brakes

C1 (*Giant evergreen forest*)

C2 *Andamans tropical evergreen forests*

E1 (*Andamans moist deciduous forests*)

C4 *West Coast tropical evergreen forests*

The finest development of this type of forest, in which giant trees predominate and the evergreen *Dipterocarps* are conspicuous is developed in Southern Burma (EDWARDS, 1950) and Malaya and it is possibly represented in the Andamans under the most favourable conditions of temperature and moisture distribution, and might perhaps be considered to be a post-climax form on deep fresh soils.

The rather inferior form differentiated as C3 is met within exposed situations in the face of the monsoon notably in the Andamans where it has some special floristic elements.

Except in the Andamans, the more accessible forests have largely been cleared for permanent or temporary cultivation and some of the present forest is secondary after past clearing. Moreover proximity to settlements has very generaly affected the forest in varying degree without amounting to clearing' as also have past unregulated and selective fellings.

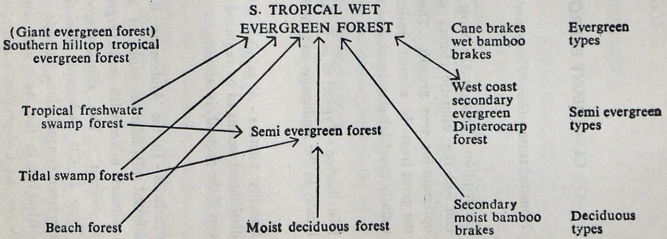
Successional relationships are difficult to determine and must often remain conjectural. The larger rivers have deltaic estuaries carrying the various seral forms of tidal forests with more or less beach forest near the sea front and brackish or freshwater swamp behind. In their higher courses, a fringe of *Lagerstroemia* (3/IS2a) is usual and there may be freshwater swamp (4C/FS2) where the fall in level is inadequate to drain off the water These swamp areas may slit up and the level further be raised by silt deposition during inundations and the forest then progresses to an evergreen

or semi-evergreen form. Except adjoining deciduous forest are grassland fire does not spread into the wet evergreen forest. Temporary cultivation particularly in hilly country results in secondary bamboo brake (2/2SI) which seems a surprisingly stable type On flatter ground on the West Coast, a secondary evergreen *Dipterocarp* forest may (2A/2SI) result from intensive felling and lopping. In other parts, temporary cultivation results in sub-evergreen forest which is partly residual, partly regrowth from surviving root-stocks and partly and new colonisation which would probably progress to the climax form unless it is cleared again when the secondary bamboo is likely to take possession.

A very characteristic predominantly briefly deciduous forest type occurs generally in the Andaman Is on freely draining slopes with evergreen or semi-evergreen forest both above and below, without any discernible climatic difference. This forest must be regarded as a stable edaphic climax occurring under the climatic conditions capable of supporting the more evergreen types on more moisture-retentive sites. It is described with the other moist deciduous types,

The following diagramatic scheme suggests probable successional relationships

Successional relationships for Southern tropical wet evergreen forest



CI — (GIANT EVERGREEN FORESTS)

Nomenclature - *Giant Evergreen*

Description - This is the most luxuriant type of forest met with the climatic climax where site conditions are optimum for tree growth. The top canopy formed by the giant trees is almost entirely evergreen and though usually irregular may locally be more or less complete.

Distribution - Typical of S. E. Asia and may be represented locally in the Andamans and the Western Ghats.

Locality Factors - A rainfall of over 3,000 mm. well distributed, seems to be required and a sufficiently retentive soil if the ground is sloping.

Floristics - In the Andamans it is met with on deep alluvial soils near the banks of larger streams but is so intimately mixed with semi-evergreen forest that delimitation is difficult. The semi-evergreen type is described in (Type 2A/Cl) Adequate floristic lists are wanting but evergreen consociations include *Dipterocarpus alatus*, the loftiest tree in the Andamans and other species such as *D- gracilis, Calophyllum soulattri* and *Artocarpus* spp.

TYPE IA/C2

C2—ANDAMANS TROPICAL EVERGREEN FOREST

Description - As given on p.79-80 for the subgroup. Not so luxuriant as the Giant Evergreen (Dipterocarp) forest particularly in the height, density and size of the giant top storey, which is very irregular and incomplete;but otherwise very similar in composition. There are fewer species in the top canopy, deciduous species being rather more frequent, and gregarious occurrence commoner.

Distribution - Throughout the Andamans typically as caps to the hills with moist deciduous forest on the slopes, Similar forest occurs in the Nicobar islands.

Locality Factors - As for the subgroup p. 81-87

Floristics —

(i) Andamans - (CHENGAPPA)

I. *Dipterocarpus grandiflorus**, *D. pilosus*, *Artocarpus chaplasha*, *A. gomeziana*, *Calophyllum soulattri**, *Planchonia andamanica-Hopea odorata Endospermum chinense*, *Sideroxylon longepetiolatum*.

II. *Xanthochymus andamanicum*, *Myristcia andamanica*, *M. glaucesceus*, *Baccaurea sapida*, *Croton argyratus*, *Pterospermum aceroides*, *Caryota mitis*, *Cryptocarya*, *Memecylon*, *Euphorbia epiphylloides*, *Pseuduvaria prainii*, *Actephila excelsa*,

III. *Anaxogorea luzoniensis*, etc.

V. *Dinochloa andamanica, Calamus palustris, Gnetum scandens, Ancistrocladus extensus.*

(ii) Gopalkabang valley, South Andamans.

I. *Dipterocarpus, kerrii*, D. grandiflorus, D. gracilis.*

II. *Artocarpus, Planchonia, Hopea odorata, Pterospermum aceroides, Myristica andamanica, Elaeocarpus.* sp.

II. *a Oxytenanthera nigrociliata*

III *Macaranga andamanica, Mussaenda macrophylla, Leea* sp. *Evodia glabra, Licuala peltata, Pandanus, Clinogyne grandis.*

IV *b. Erianthus arundinaceus.*

V. *Dinochola andamanica, Ancistrocladus, Calamus palustris, C. longisetosus, C. Pseudorivalis, Gnetum scandens.*

NOTE : *Dipterocarpus* forms a more or less pure stand in the top storey but is present in all layers

(iii) Great Nicobar Islands - (SAHNI)

I. *Calophyllum soulattri*, Sideroxylon longeperiolatum, Garcina xanthochymus, Adenanthera pavonina, Albizzia lebbek, Pisonia umbellifera, Mangifera sylvatica,*

II. *Myristica* spp. *Polyalthia* spp.

NOTE – This type covers the hills ; the valleys forests have a different composition and include *Musa* spp. and tree ferns, as well as the extensive climbing bamboo *Dinochloa*, *Dipterocarpus* is absent.

General NOTE - *Dipterocarpus grandiflorus* is a conspicuous member of evergreen forests occuring on moist clayey hill slopes which are best viewed as examples of Type IA/C2, page 93 Similarly the *Dipterocarpus kerrii* association which is dominated by this species but only attains a moderate height, occurs in a few restricted localities in S. Andamans.

C2/E1 - (Andamans moist deciduous forest)

This is described under 3A/C1

Type IA/C3

C3—SOUTHERN HILL TOP TROPICAL EVERGREEN FOREST

Description – A more or less inferior edition of the typical wet evergreen, not more than 10 m. high in extreme cases.

Distribution - Andamans, and W. Ghats, on the upper slopes and tops of hills, and sometimes on steep slopes lower down.

Locality Factors - Exposure to wind and generally less favourable conditions of soil and climate than the main climax form. Rainfall is usually high, over 4,500 mm. and humidity is high during the period of low rainfall.

Floristics

(i) Andamans- (PARKINSON AND CHENGAPPA)

I *Dipterocarpus costatus*,* *Mesua ferrea, Canarium manii, Harpullia cupanioides, Hopea andamanica, Cratoxylon formosum, Euphorbia trigona* and *E. epiphylloides*.

II *Memecylon caeruleum, Cryptocarya ferrarsi* and some small bamboos. *Phoenix* sp. (local)

NOTE —Apparently a true edaphoclimatic climax in- the areas mentioned, sometimes forming a transition to the subtropical montane type.

(ii) Ranni, Kerala, Cir. 1000 m. (PILLAI)

I & II *Mesua ferrea**, *Dysoxylum malabaricum, Cullenia excelsa, Holigarna beddomei, Calophyllum elatum, Cedrela toona, Canarium strictum, Artocarpus heterophyllus, Palaquium ellipticum, Hopea parviflora, Eugenia* spp, *Elaeocarpus* sp.

II a *Ochlandra travancorica*

III. *Pandauus, Strobilanthes.*

V. *Calamus* spp.

(iii) Muthukuzhi, Tirunelveli South Division, Madras 1200 - 1500 m.

I. *Hopea Parviflora*, Calophyllum elatum*, Dysoxylum malabaricum Cullenia excelsa, Arotcarpus hirsuta, Lophopetalum wightianum, Tetrameles nudiflora.*

II. *Syzygium cumini, Cinnamomum zeylanicum, Elaeocarpus serratus, Macaranga roxburghiana.*

III. Dense evergreen shrubs and reeds.

V. *Canes, Entada phaseoloides, Calycopteris flori bunda, Disocorea* sp.

TYPE IA/C4

C—4 WEST COAST TROPICAL EVERGREEN FOREST

Description- As given for the subgroup on p. 79-80 except that the genus *Dipterocarpus* is infrequent or absent and that there are other characteristic flortstic difference as revealed by the lists given.

With increasing elevation and high rainfall the height of the forest diminishes-though it remains dense and evergreen-changing into the reiatively stunted montane wet subtropical forest. There is no sharp line of change although a plateau configuration may reduce the extent of transition stages.

Distribution - All along the western ghats from about Ratnagiri district southwards wherever humidity and soil moisture conditions are favourable.

Locality Factors - Rainfall 1500-5000 mm. or more; altitude 250 to 1200m. Mangalore and Cochin may be taken as fairly typical though neither is in the forest belt.

Floristics - High level type.

(i) Kanara Eastern, Mysore.

I. *Dipterocarpus indicus**, *Calophyllum elatum*, *C. wightiamum*, *Hopea wightiana Holigarna arnottiana*, *H. grahmii*, *Olea dioica*, *Lophopetalum wightianum*, *Polyalthia coffeoides*, *Machilus macarantha*, *Mangifea indica*, *Chrysophyllum roxburghii*.

II. *Aglaia roxburghiana*, *Euphorbia longana*, *Aporosa Lindleyana*, *Lansium anamallaynum*, *Nothopegia colebrookiana*, *Litsea* spp. *Ponteria tomentosa*, *Flacourtia montana*, *Caryota urens*, *Areca*.

III. *Strobilanthes* spp., *Psychotria* spp. *Leea*.

V. *Canes*.

NOTE : *Dipterocarpus indicus* and *Calophyllum elatum* together account for about 5% of the crop, *D. indicus* towers over others.

(ii) Agumbe, Mysore (ghat crests 300-800 m).

I *Dipterocarpus indicus** (a), *Poeciloneuron indicum* (a). *Mesua ferrea* (a), *Hopea parviflora* (o), *Dysoxylum malabaricum*, *Calophyllum elatum*, *Machilus macrantha*, *Palaquium ellipticum* and many others.

II *Myristica* sp. *Euphoria longana*, *Lansium anamallyanum*, *Unona pannosa*, *Humboldia brunonis*, *Aglaia odoratissima*. *Hopea wightiana* etc.

II *a* *Oxytenanthera* spp.

III *Rubiaceae*, *Strobilanthes- Pinanga Dicksonii Arenga wightii*, *Pandanus*.

V *Calamus* spp.

(*iii*) Makut (Coorg), Mysore.

I *Vateria indica** (a), *Kingiodendron pinnatum* (a) *Dipterocarpus indicus* (a) *Cedrela* sp. (o), *Mesua ferrea* (o) *Holigarna arnottiana* (o), *Mangifera* spp. (o) *Artocrapus hirsuta* (o), *Dysoxylum malabaricum* (o), *Hopea parviflora* (f) *Calophyllum elatum* (f)

II *Elaeocarpus* spp. (a) *Myristica* spp. (a) *Hemiacyclia elata* (a), *Dichopsis elliptica* (f), *Schleichera-oleosa*, *Canarium strictum*.

(iv) High level evergreen forests of wynad, Kerala,

The forest are characterised by a high proportion of *Mesua forrea*, *Palaquium* ellipticum*, *Cullenia excelsa* and *Calophyllum elatum*. The absence of *Dipterocarpus indicus*, *Filicium*, *Kingiodendron pinnatum* and *Hopea* is not worthy; these species are met with at lower elevations in the adjoining Kannoth block, where *Mesua* is absent.

I *Palaquium ellipticum* (a), *Vateria** (a), (especially near water courses), *Calophylum elatum* (o), *Cullenia excelsa*. (o), *Dysoxylum malabaricum* (lo) *Artocarpus hirsuta* (r), *Cedrela toona* (o), *Machilus macrantha* (o) *Mesua ferrea* (f) *Elaeocarpus tuberculatus* (f) *Bischofia* (f), *Eugenia* spp. (f) *Canarium* (f)

II *Palaquium ellipticum* (a), *Myristica spp*. (o) *Vateria* (f) *Eugenia Mnnronii* (f), *Actinodaphne hirsuta* (f), *Ostodes* (f), *Euphoria longana* (f) *Litsea sp*. (f), *Meliosma simplicifolia* (f) *Polyalthia coffeoides* (f), *Cinnamamum zeylanicum* (f), *Elaeocarpus serratus* (f) etc.

II *a* Bamboos appear mainly as *Ochlandra* brakes along the larger streams but occasionally spread out on the slopes.

III *Leea indica* (a), *Rubiaceae* (a), *Apama* (a) *Areca*-(la), *Strobilanthes* spp. (la), *Psychotria*, *Lasian*, *thus*, *Pandanus* sp. (la), *Glycosmis* (f), *Calamus* sp. (if), *Laportea crenulata* (f) Large ferns (f)

IV b. No grass in undisturbed forest

V, Climbers on the whole are not heavy though locally they may be so.

(v) Karian Shola Anamalias, Madras (LAURIE)

I. *Hopea parviflora** (a), *Mesua ferrea** (a) *Vitex altissima* (a), *Aglaia roxburghiana* (a), *Elaeodendron glaucum* (a), *Polyalthia fragrans* (a), *Diospyros microphylla* (a) *Eugenia gardneri* (a) *Canarium strictum* (o), *Artocarpus lakoocha* (o), *Bischofia javanica* (o), *Artocarpus heterophyllus* (o), *Trewia nudiflora* (o), *Alstonia scholaris* (o), *Dysoxylum malabaricum* (o), *Machilus macrantha* (o), *Filicium decipiens* (o), *Tetrameles nudiflora* (o), *Carallia lucida* (o), *Beilschmiedia bourdillonii* (o), *Pygeum wightianum* (o) *Calophyllum elatum* (f), *Salmalia malabarica* (f), *Spondias pinnata* (f), *Litsea* sp. (f), *Mangifera indica* (o).

II *Cyclostemon macrophyllus* (a), *Gomplandra polymorpha* (a), *Dimorphocayx lawianus* (a), *Euphoria longana* (a), *Scolopia crenata* (a) *Excaecaria robusta* (a), *Diospyros bourdilloni* (a), *Acronychia pedunculata* (a), *Adenochlaena indica* (a) *Garcinia* sp, (a), *Canthium dicoccum* (c), *Mallotus philippensis* (o), *Flacourtia indica* (o), *Sapindus laurifolius* (o), *Harpulia arborea* (o), *Fagara budrunga* (o), *Hydnocarpus wightiana* (o), *Actinodaphne hirsuta* (o), *Cinnamomum wightianum* (f)

Pterospermum heyneannm (f), *Mimusops elengi* (f), *Amoora canarana* (f), *Holigarna grahami* (f) *Prosorus indicus* (f), *Ostodes zeylanica* (f) *Myristica laurifolia* (f), *Casearia esculenta* (f)

III. *Strobilanthes* spp. (a), *Orophea zeylanica* (o), *Nothopegia* sp, (o), *Ixora arborea* (o).

IV. *Entada phaseoloides* (o), *Calamus* spp. (f),

vi High level evergreen forests of Palghat (Kerala)

I. *Cullenia excelsa**, *Machilus macrantha Elaeocarpus tuberculatus*, E. *munroii*, *Palaquim ellipticum*, *Mesua ferrea**, *Calophyllum elatum Canarium strictum*, *Dysoxyulm**, *malabaricum*, *Vateria indica*, *Poeciloneuron indium**, *Eugenia* sp,, *Heritiera papilio*, *Donella roxburghii*, *Mangifera indica*, *Artocarpus heterophyllus*, *Polyalthia coffeoides*, *Cinnamomum zeylanicum*, *Holigarna arnottiana*, *H grahamii*, *Meliosma*, *microcarpa*, *Hopea glabra*, *Litsea wightiana*, *Mastixia arborea*, *Dryptes elata*, *Cyclostemon confertiflorus*, etc.

II. *Myristica laurifolia*, *Hydnocarpus laurifolia*, *H*, *alpina*, *Euphoria longana*, *Lansium anamalayanam*, *Garcinia spicata*, *Elaeocarpus serratus*, *Symphyllia mallotiformis*, *Gomphandra polymorpha*, *Gordonia obtusa*, *Syzygium* sp., *Baccaurea courtallensis*, *Glochidion malabaricum*, *Canthium dicoccum*, *Scolopia crenata*, *Xanthophyllum flavescens*, *Nothapodytes foetida*, *Actinodaphne hookeri*.

II a, *Ochlandra beddomei.*

III, *Euonymus angulatus*, *Agrostachys indica* *A. longifolia*, *Eugenia munronii*, *Syzygium lineatum*, *Paramignva beddomei*, *Sauropus albicans*, *Leea indica*, *Saprosma fragrans*, *Webera* sp., *Clerodendron viscosum*, *Macaranga peltata*, *Strobilanthes* sp., *Laportea crenulata*, *Olea dioica* *Linocera malabarica*, *Callicarpa lanata*, *Pavetta zeylanica* *Vernonia arborea*, *Turpenia malabarica* *Orophea uniflora*, *Sarcococca brevifolia* *Croton scabiosus*. Monocotyledonous forms include *Arenga wightii* *Pinanga dicksonii*, *Calamus* spp., *Pandanus furcatus*.

IV a. Herbaceous ground flora-*Elettaria cardomomum*, wild arrow root, *Curcuma* sp., *Heckeria subpeltata*

V. Climbers - *Gnetum scandens*, *Calamus* sp., *Smilax zeylanica*, *Elaeagnus latifolia*, *Derris* sp., *Entada phaseoloides*, *Senecio araneosus* *Thunbergia mysorensis*, *Paramignya* sp., *Luvunga eleutherandra*, *Morinda* spp.

NOTE : This form is found in the Silent and Attapadi valleys *Palaquium ellipticum* is by far the most abundant species. Common also are *Mesua ferrea*, *Poeciloneuron indicum*, *Cullenia excelsa*, *Machilus macrantha*, *Calophyllum elatum*, etc. Considerable occurrence of *Poeciloneuron indicum*

is specially noticeable and the absence of *Dipterocarpus* species is also noteworthy.

(vii) *High Level Evergreen Forests of Nilambur* (*Kerala*).

I, *Palaquium ellipticum**, *Cullenia excelsa*, *Calophyllum elatum*, *Terminalia belerica*, *Machilus macrantha*. *Dysoxylum malabaricum*, *Elaeocarpus tuberculatus*, *Artocarpus hirsuta*.

II. *Eugenia gardeneri*, *Cinnamomum zeylanicum*, *Bischofia javanica*, *Cedrela toona*, *Elaeocarpus* sp,, *Xyldoia parviflora*.

II a. *Ochlandra* spp. are met with as gregarious batches.

III. *Strobilanthes*, *Rubiaceae*, *Pinanga dicksonii*, *Arenga wightii*.

V. Climbers - *Entada phaseoloides*, wild pepper, *Smilax*, etc. occassional *Calamus*.

NOTE: Here *palaquium* is the commonest species, *Hopea* is found sparesely, scattered below 750*m*. *Mesua ferrea* is abundant from 900 m. to 1,200m. *Calophyllum* tends to be *gregarious* in patches. *Dipterocarpus* is absent

Low level type

(i) *Wynad*, (*Kerala*).

I. *Vateria indica** (a), *Artocarpus hirsuta* (f), *Dysoxylum malabaricum* (f), *Acrocarpus*

fraxinifolia (o). *Hopea parviflora** (a), *Diptero-carpus indicus* (f), *Filicium decipiens* (f), *Kingiodendron pinnatum* (f), *Elaeocarpus* sp. (f), *Bischofia javanica* (o), *Cedrela toona* (f), *Eugenia* sp. (f).

II. *Myristica* sp. (o), *Litsea* sp. (f) *Hydnocarpus laurifolia** (a), *Pterygota alata* (o). *Vitex altissima* (o), *Schleichera oleosa* (f), *Cinnamomum* sp. (o), *Pterospermum rubiginosum* (f).

III. *Leea indica* (a), *Strobilanthes* (f), *Calamus* sp. (lf), *ferns* (la), *Rubiaceae* (a), *Arenga wightii* (la)

IV Grasses - do not occur.

V. Climbers not heavy

(ii) *Kanara Eastern*, *Mysore*, Devimone 300 m.

I. *Hopea wightiana** *Diospyros candoleana*, *Olea dioica*, *Syzygium cumini*, *Holigarna arnottiana*, *Pterospermum heyneanum*, *Memecylon edule*, *Cinnamomum* spp., *Syzygium gardneri*, *Artocarpus heterophyllus*, *A. hirsuta*, *Lophopetalum wightianum*, *Calophyllum elatum*, *Machilus macrantha*, *Mangifera indica*, *Mimusops elengi*, *Terminalia paniculata*, *Lagerstroemia lanceolata*.

II. *Aglaia roxburghiana*, *Garcinia* sp., *Symplocos canarana*, *Canthium dicoccum*, *Euphoria longana*

Aporosa Lindleyana, Saraca indica, Litsea spp. *Flacourtia montana, Pouteria tomentosa, Madhuca longifolia, Hydnocarpus laurifolia.*

II. a. Bamboos are practically absent.

III, *Strobilanthes* spp., *Psychotria dalzelli, Leea sambusina, Goniothalamus, Litsea* spp.

V. Canes common, sometimes abundant.

NOTE : Regeneration of the main species is frequent.

GENERAL NOTE : There are some differences between the low level forms met with from 250 to 500 m, illustrated by examples and the high level forms which are typical and best developed examples of west coast evergreen forests, described above. In the low level form *Cullenia excelsa* and *Poeciloneuron* are absent and *Mesua ferrea, Palaquium* and *Calophyllum elatum* are less frequent. There is a high proportion of *Hopea parviflora, Kingiodendron pinnatum, Artocarpus hirsuta, Acrocarpus fraxinifolius Vateria indica* etc.,. *Hopea* tends to be gregarious and is quite abundant. *Vateria* is also abundant. Floristics lists are given by CHANDRASEKHARAN.

The principal characteristic of **a** *selection of the associations in the southern west coast region are summarised in the following table*

Some Typical Association of West Coast Tropical Evergreen Forests

	Association	Typical altitude	Typical soil	Typical rainfall	Typical status	Typical occurrence
1.	*Filicium-Alseodaphne*	250-600 m.	shallow, lateritic	2500 mm.	edaphic climax	TIRUNELVELI-Madras
2.	*Hopea-Mesua*	300-500 m.	moderately moist	3000 mm.	low elevation climax	SOUTH COIMBATORE, KANYAKUMARI-Madras
3.	*Poeciloneuron-Mesua*	320-800 m.	moist	cir. 5000 mm	climax	AGUMBE- Mysore
4.	*Hopea* (*wightiana*)-*Pala quium*	320-800 m.	drier	cir. 5000 mm.	takelnad climax	HASSAN - Mysore

	Association	Typical altitude	Typical soil	Typical rainfall	Typical status	Typical occurrence
(4a)	*Elaeocarpus tuberculatus*	—	moister	cir. 5000 mm.	edaphic variant of *Vateria*	AGUMBE-Mysore
5.	*Poecilone-uron-Dip. terocarpus*	320-800 m.	moist	cir 5000 mm	moist climax	AGUMBE-Mysore
6.	*Palaquium-Dipterocarpus*	cir. 650 m.	moist, well drained	cir. 5000 mm.	climax	HASSAN-Mysore THENMALA-Kerala
(6a)	*Hopea wightiana*	cir. 650 m.	drier, lateritic	—	transitional edaphic climax on steep slopes	AGUMBE, HASSAN-Mysore
(6b)	*Lophopetalum wightianum*	cir 650 m.	wet, marshy	—	edaphic climax, variant of *Vaterin*	AGUMBE, HASSAN-Mysore

	Association	Typical altitude	Typical soil	Typical rainfall	Typical status	Typical occurrence
(6c)	*Vateria indica*	cir. 650 m.	wet stream banks	—	edaphic climax, variant of *Elaeocarpus (4a)* or *Lophopetaum (6b)*	HASSAN-Mysore
7.	*Dipterocarpus-Hopea*	cir. 650 m.	moist, deep clayey loam	cir. 5000 mm.	low elevation climax	KANARA EAST-Mysore
8.	*Palaquium-Mangifera*	650-800 m.	clayey, slowly drained	4000 mm.	medium etc vation climax	TIRUNELVELI-KANYAKUMARI-Madras
(8a)	*Gluta-Palaquium*	—	moister	—	edaphic climax	TIRUNELVELI-Madras
9.	*Cullenia-Palaquium*	800-1100 m.	deep, well drained	5000 mm.	medium elevation climax	PALGHAT-Kerala TIRUNELVELI-Madras

	Association	Typical altitude	Typical soil	Typical rainfall	Typical status	Typical occurrence
(9a)	*Ochlandra-Calophyllum*	—	wet	4000-5000 mm.	edaphic post climax	PALGHAT-Kerala
(9b)	*Vateria-Cullenia*	—	moister, well drained	—	edaphic climax	PALGHAT-Kerala
(9c)	*Cullenia-Palaquium-Mesua*	—	drier	—	altitudinal variant	PALGHAT-Kerala
10.	*Diptero-carpus-Vateria*	cir. 1000 m.	well drained	6000 mm.	optimum moisture climax	BISALE-Mysore
(10a)	*Vateria-Elaeocarpus*	—	wet	—	edaphic climax along streams	BISALE-Mysore

	Association	Typical altitude	Typical soil	Typical rainfall	Typical status	Typical occurrence
11.	*Palaquium-Mesua*	1000-1200 m.	moist	4000 mm.	medium elevation climax	AGUMBE-Mysore SOUTH-TIRUNELVELI-Madras
12.	*Cullenia-Calophyllum*	over 1100 m.	wet	3000 mm.	edaphic past climax	KANYA-KUMARI-Madras
13.	*Poeciloneu-ron-Pala-quium*	1000-1200 m.	damp or wet	5000 mm.	optimum moisture climax	AGUMBE; KADUR-Mysore
14.	*Poeciloneu-ron-Cullenia*	1000-1200 m. (Ghat crests)	damp	5000 mm.	optimum moisture climax	SOUTH COIM-BATORE-Madras
14a)	*Elaeocarpus tuberculatus*	—	moist	—	edaphic variant	AGUMBE-Mysore

Association	Typical altitude	Typical soil	Typical rainfall	Typical status	Typical occurrence
(14b) *Vateria-Mesua*	Over 1200 m.	damp or wet	—	edaphic climax	PALGHAT-Kerala
14c) *Ochlandra-Poeciloneuron*	—	marshy	—	edaphic post climax	PALGHAT-Kerala
(14d) *Poeciloneuron*	—	damp or wet	—	edaphic climax near streams	KADUR-Mysore
15. *Mesua-Calo phyllum*	1100-1300 m.	moister	5000 mm.	high elevation climax	PALGHAT-Kerala

TYPE IB/EI and E2

General Edaphic and Seral types of wet evergreen forests

E1 — CANE BRAKES

DESCRIPTION - An impenetrable thorny thicker sometimes with a few tall trees standing over it, sometimes, without. The stems are typically trailing and may be 60 m or more long but some species are more or less erect.

DISTRIBUTION – Throughout the evergreen and semi-evergreen climaxes and locally in moist deciduous forest.

LOCALITY FACTORS - Occurs in wet hollows extending outwards to various distances, becoming more conspicuous with heavier and better distributed rainfail ie. in the wet tropical evergreen The soil is permanently wet and usually fine clay, very rich in humus.

FLORISTICS - *Calamus* spp. and sometime the creeping bamboo *Neohouzeana*. A few palms such as *Licuala* and *Zalacca*. The species vary with locality permitting differentiation of a number of forms.

NOTE ; Once the creeping canes are in possession of a site they make it almost impossible for trees to push through but they require a constant and abundant water supply for optimum development *Calamus tenuis* brakes extend well into the moist sal forests in Uttar Pradesh.

E2 — WET BAMBOO BRAKES

DISCRIPTION - The brakes are often very dense, even if the bamboos grow in clumps. The bamboos tend to be of the smaller types rather than the big clumped species.

DISTRIBUTION - Throughout the tropical evergreen tracts of S. India and Andamans.

LOCALITY FACTORS - Wet bomboo brakes are usually found along streams or on badly drained hollows more or less displacing the tree forest, whilst cane brakes replace them in the wettest sites.

FLORISTICS

(ii) South India

I, Trees of the tropical forest.

II a. *Oc hlandra* Spp.

NOTE ; Species of *Ochlandra* (reeds) frequently occur in damp sites in the evergreen and semi-evergreen forests and are prone to extend considerably if the canopy is broken from any cuase. As. however, the major occurrences are mostly in the higher hills, they are described under the subtropical vegetation types.

TYPE IB 2SI

2SI — PIONEER EUPHORBIACEOUS SCRUB

In most moist evergreen and semi-evergreen forests, if a heavy or clear felling is made and the area is then left to its natural regrowth, it very commonly occurs that a cover of quick growing but short lived small trees is quickly established. The *Euphorbiaceous* genera *Macaranga*, *Mal lotus* and *Trema* usually predominate as a first stage in the secondary sere, provinding shade and shelter under which the slower and less adaptable species of the latter stages become established and ultimately push through and supplant the pioneers.

FLORISTICS

(ii) South Kerala (LEGRIS AND VIART)

I/II *Macaranga indica**, *Mallotus philippensis**, *Sterculia urens*, *Vernonia travancorica*, *Trema orientalis**, *Grewia tiliaefolia*, Bamboos

SUBGROUP 2A

GROUP 2 TROPICAL SEMI - EVERGREEN FORESTS

Subgroup 2 A Southern tropical semi-evegreen forests

1. NOMENCLATURE

See corresponding entries under individual types below

2. GENERAL DESCRIPTION

This type is very variable and difficult to define except in comparative terms, being intermediate between the tropical evergreen and moist deciduous forms but usually including groups or patches fairly typical of both. It accordingly forms a closed high forest the dominant trees sometimes running to big dimensions but usually inferior to Type la, and includes both evergreen and deciduous trees the former predominating - intimate mixture but with a definite tendency to gregarious occurrence. The number of species is high but less so than in the true evergreen, many of the biggest evergreen being absent. Buttressed stems continue to be frequent and occur in both evergreen and deciduous species (e. g. *Elaeocarpus* spp. and *Salmalia*). Bark tends to be thicker and rougher and cauliflory rarer. The general canopy is typically less dense

than in the true evergreen and the evergreen undergrowth rather more copious; climbers tend to be very heavy. Bamboos are usually pesent but less prevalent than in the moist deciduous. Epiphytes are abundant including many ferns and orchids.

3. DISTRIBUTION

The type occurs throughout the moister parts of southern tropics always in association with the true evergreen, but it does not occupy a very large area as there are but few extensive tracts where the moisture conditions are adequate for its development but at the same time inadequate for an evergreen climax. This is particularly marked in the Western Ghats where the rainfall gradient is very steep. A suitable rainfall is also met with just north of Bombay, near Goa, and south of Cochin over areas large enough to develop a typical vegetation.

It is also frequently encounted as an edaphic subclimax to tropical evergreen on shallow porous soils.

4. LOCALITY FACTORS

TEMPERATURE - The mean annual temperature is about 26°C, the January mean 21°C - 24°C, and mean maximum about 16°C, whilst the mean extreme minimum is not below 10°C.

TEMPERATURE DATA (CENTIGRADE)
SOUTHERN TROPICAL SEMI-EVERGREEN FORESTS

Month	Mysore KARWAR 4 m.			Kerala MANGALORE 22 m.		
	Mean	Mean max	Mean min.	Mean	Mean max.	Mean min.
Jan.	25·8	31·8	19·7	26·6	31·7	21 4
Feb.	25·5	30·6	20·3	26 8	31·1	22·5
March	26·7	30 9	22·4	28·2	32·0	24·3
April	27·8	31·3	24·4	29 4	32·9	25·8
May	28·7	31·4	25·9	29 3	32·7	26 6
June	26·2	28·3	24 0	26·6	29·2	23·8
July	25·8	27·7	24·0	26 1	28·7	23·5
Aug.	25 6	27·4	23·8	26·2	28·8	23·4
Sept.	26·4	28 9	23·9	26·3	29·1	23·5
Oct.	26 7	29·9	23 8	26·8	29·9	23·7
Nov.	25·4	31·1	19·7	27·1	31 0	23·1
Dec.	25·2	31·3	19·1	26·8	31·7	21·4

	KARWAR	MANGALORE
M. A. T.	26·3	27·2
Annnal mean max.	50·0	30·7
Highest record	?	37·8
Annual mean min.	22·6	23·6
Lowest record	?	16·7
No. of years	Upto 1955	60

RAINFALL – As the occurrence of the type seems to be determined in many places more by edaphic than climatic causes, the records for stations in or near it show a considerable range. The typical rainfall is probably between 2000 mm. and 2500 mm. rarely less, but frequently much more. Karwar (on the west coast) and Yellapur (at the top of the Ghat above Karwar) are more or less typical for the Western Ghats.

RAINFALL (MILLIMETERS)

SOUTHERN TROPICAL SEMI-EVERGREEN FORESTS

Month	Coorg SOMVAR-PET 1131 m.	Mysore SAGAR (Shimoga) 515 m	Mysore KARWAR 4 m.	Mysore YELLAPUR 565 m.
1	2	3	4	5
Jan.	3	2	1	1
Feb.	3	2	1	1
March	12	9	0	8
April	64	44	12	35
May	103	63	86	56
June	355	399	951	510
July	757	747	944	964
Aug.	439	394	542	554
Sept.	153	141	276	184
Oct.	172	142	147	136
Nov.	83	41	42	27
Dec.	17	8	6	5
Total for year (M. A. R.)	2,183	1,994	3,006	2,495
No. of rainy days	110	98	104	104

No. of months with less than 50 mm.	4	5	6	5
M. A. humidity	—	—	80	—
No. of years	50	71	57	63

ROCK AND SOIL - Tropical red soils for the most part, overlying a variety of rocks, mainly crystalline rocks in the W. Peninsula.

TOPOGRAPHY - Almost entirely on low hilly or undulating ground though also occurring on fairly flat plateau country.

5. GENERAL FLORISTICS

In the upper canopy, *Xylia* and *Terminalia* are most typical but Dipterocarps also frequently occur, (*Dipterocarpus, Balanocarpus, Hopea*). The middle canopy is made up of evergreen *Myrtaceae, Schleichera oleosa, Lauraceae,* etc Bamboos, when present, are *Bambusa arundinacea* (W) *B polvmorpha* and *Cephalostachyum pergracilc* (E). The ground cover is largly made up of, evergreen shrubs including various *Rubiaceae* and *Acanthaceae*.

6. SUBDIVISONS, SUCCESSIONS, ETC.

Only two forms call for separation on present information, one of them being conditioned primarily by the hard, more or less lateritic soil and frequently also found under the climatic conditions appropriate to the evergreen types.

The primary seres are indistinguishable form those of the evergreen forests and include beach, tidal swamp and riverain types. Clearing is again likely to result in the development of secondary bamboo brakes in hilly country whilst eleswhere secondary semi-evergreen (2A/2SI) and secondary moist deciduous (3B/2SI) are found.

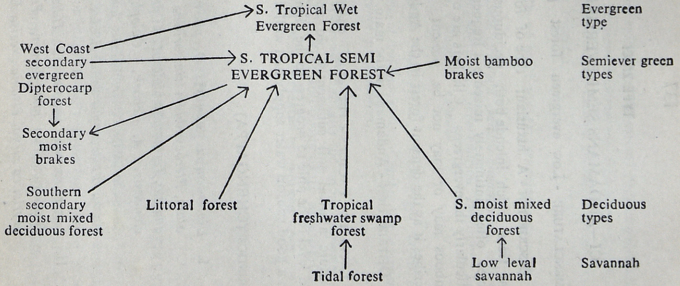
C1 Andamans semi-evergreen forest.

C2 West Coast semi-evergreen forest.

C3 Tirunelveli semi-evergreen forest.

2SI West Coast secondary evergreen Dipterocarp forest.

Successional relationships for Southern tropical semi-evergreen forests



TYPE 2A/CI

CI—ANDAMANS SEMI-EVERGREEN FORESTS

NOMENCLATURE - Low evergreen forest (CHENGAPPA)

DISCRIPTION - A luxuriant type of forest wite many giant trees which inlcude both deciduous and evergreen species often intimately mixed but frequently in groups, particularly the evergreens. Climbers are often heavy. Bamboos may or may not be present. CHENGAPPA describes it as the densent forest in the Andamans.

DISTRIBUTION - Andamans in the main valleys.

LOCALITY FACTORS - The chief characteristic is the immature alluvial soil sufficiently old and raised above flood level to be able to progress to the climatic climax, but with a good subsoil water supply and well drianed soil

FLORISTICS (CHENGAPPA)

I. *Dipterocarpus alatus* D. pilosus*, Pterygota alata, Pterocymbium tinctorium, Sterculia campanulata, Terminalia bialata*, T. procera*, Albizzia chinensis, A, lebbek, Calophyllum soulattri, Salmalia insignis, Artocarpus lakoocha, A, chaplasha, Pterocarpus dalbergioides.*

II. *Lagerstroemia hypoleuca, Dillenia pentagyna Dracontomelum mangiferum, Pometia pinnata, Myristica xirya, Pisonia excelsa Litsea punumnia,*

Xanthophyllum andamanicum, Fragraea morindaefolia, Talauma andamanica, Garcinia andamanica, Aporosa villasula, Licuala peliata, Caryota mitis, Areca triandra,

IIa. Usually no bamboos. *Oxytenanthera* sp. (I)

III. *Saprosma ternatum, Maesa andamanica, Mieromelum pubescens, Clerodendrum viscosum, Leea indica, Clinogyne grandis*

V. *Dinochloa andamanica, Thunbergia laurifolia, Buettneria andamanensis, Combretum extensum, Daemonorops, Calamus,*

NOTE : The type is economically the most important of the Andamans, and owing to its accessibility, it is being steadily cleared or worked over.

TYPE 2A/C2

C2 — WEST COAST SEMI-EVERGREEN FOREST

DISCRIPTION - Intermediate between estern tropical evergreen and the moist deciduous forest with evergreen and deciduous dominants usually intimately mixed though extensive consociations are met with notably of *Xylia*. Lower storey mainly evergreen. *Bambusa arundinacea* is the typical bamboo.

DISTRIBUTION - In the W. Ghats, generally between the wet evergreen and the moist deciduous but usually only as a narrow strip which has often been destroyed especially at the north end) or greatly altered by biotic influences.

LOCALITY FACTORS - Rainfall from 2,000 - 2,500 mm, locally much more. Mostly on hill slopes from 450 to 1,050 m. but also on the plains.

FLORISTICS

(i) S. Kanara, Mysore.

I. *Terminalia paniculata**; *Diospyros* spp., *Lagerstroemia lanceolata, Holigarna arnottiana, Lophopetalum wightianum, Machilus macrantha, Cinnamomum* sp., *Hopea parviflora, Artocarpus hirsuta.*

II *Elaeocarpus serratus, Mallotus phi'ippensis Diospyros assimilis, Ixora arborea,*

III *Webera, Strobilanthes* spp. *Ixora malabarica*

IV. Climbers and canes numerous.

(ii) Wynad and Palghat, Kerala.

I. *Artocarpus hirsuta, Salmalia malabarica, Vitex altissima, Tetrameles nudiflora, Acrocarpus fraxinifolius**, *Hopea parviflora**, *Lagerstroemia lanceolata, Vateria indica, Anthocephalus cadamba Xylia Xylocarpa, Terminalia tomentosa, Cedrela toona, Grewia tiliaefolia, Dalbergia latifolia, Pterospermum rubiginosum. Radermachera xylocarpa, Mesua ferrea, Adina cordifolia, Holoptelea integrifolia, Pterocarpus marsupium, Sterculia guttata*

II. *Hydnocarpus laurifolia, H. alpina, Bischofia javanica, Mallotus philippensis, Kydia calycina, Schleichera oleosa, Evodia lunu-ankenda.*

IIa. *Bambusa arundinacea, Ochlandra* sp.

(iii) Trivandrum, Kerala.

I. *Artocarpus hirsuta* (o). *Hopea parviflora** (f) *Adina cordifolia* (o), *Lagerstroemia lanceolata* (o), *Terminalia paniculata** (a), *T. tomentosa** (a) *Salmalia malabarica* (o), *Tetrameles nudiflora* (la), *Vitex altissima* (f), *Holoptelea integrifolia* (o), *Vateria indica* (lf), *Lophopetalum* (f), *Pterocarpus marsupium* (f)' *Colophyllum elatum* (la), *Machilus macrantha** (a), *Grewia tiliaefolia* (o), *Terminalia belerica* (o),

II. *Polyalthia fragrans, Canarium strictum, Cinnamomum zeylanicum, *Aporosa Lindleyana, Mallotus philippensis, Xanthophyllum, flavescens Emblica officinalis, Bridelia retusa, Albizzia odoratissima.*

IIa Bamboos and reeds very common.

III *Clerodendron, Glycosmis pentaphylla, Strobilanthes* sp,

IV. *Entada phaseoloides, Butea parviflora, Strychnos colubrina, Dioscorea* sp,

TYPE 2A/C3

C3 — TIRUNELVELI SEMI-EVERGREEN FOREST

DESCRIPTION Closed forest rarely exceeding 30m. in height with a two or three storeyed canopy which is rather open February to April. Epiphytic moss and lichens are not conspicuous but orchids. occur. Climbers fairly numerous and canes are abundant at the higher levels.

DISTRIBUTION - On the eastern slopes of the southern W. Ghats between 250 and 550 m. or even 1,000 m. between the wet evergreen above and the moist deciduous below, as a relatively narrow strip.

LOCALITY FACTORS - Rainfall almost equally from both monsoons, 1,900 - 2,500 mm, with no rainfall from January April. Soil red gravelly and semi-laterite, well drained.

FLORISTICS

Tirunelveli Division (LASRADO)

I *Hopea (Balanocarpus) utilis**, *Hopea parviflora*' *Pterospermum* spp. *Kingiodendpron innatum* *Stereospermum personatum*, *Dalbergia latifolia*, *Chukrasia*, *Artocarpus heterophyllus*.

II. *Aglaia* spp.. *Euphoria (Nephelium) longana*, *Dry petes venusta*, *Bischofia*, *Carallia*, *Diospyros* spp.

III. *Strobilanthes* spp. *Glycosmis*.

TYPE A 2/SI

2S/1. WEST COAST SECONDARY EVERGREEN DIPTEROCARP FOREST

DESCRIPTION - Nearly pure forest of evergreen *Diptero carpacae* of relativelypoor development but with an even and typically dense canopy, without a definite middle storey but with an undergrowth of evergreen shrubs.

DISTRIBUTION - On the coastal plain below the W Ghats.

LOCALITY FACTORS - A high rainfall of over 2,500 mm. and a hot equable climate typified by Mangalore (pp.82to85) Stiff red tropical soils often lateritic on fairly level country intersected by network of eroded depressions.

FLORISTICS

(i) Pilakarkhan, N. Mangalore Division

I. *Hopea parviflora** (a), *H. wightiana** (la), *Vateria indica* (la), *Diospyros microphylla* (f).

II. *Aporosa Lindleyana* (a), *Olea dioica* (f).

IIa No bamboo

III *Memecylon sp.*, (a) *Syzygium caryophyllatum* (a), *Rubiaceae* (a), and *Acanthaceae* (f).

IV *Calycopteris* (f),

NOTE : Thisis easily recognizable form of residual forest on the coast owing its existence entirely to human activities among which lopping for green manure is most important. The poorer soils revert to deciduous forest but the last stages of denudation are typically evergreen scrub (*Ixbra coccinea*, *Syzygium caryophyllatum*, *Phoenix*) and finally short tufted grass with scattered bushes of *Calycopteris*.

ii Kerala.

I/II *Polyalthia fragrans*, *Vateria indica*, *Knema attenuata*, *Tetramels nudiflora*, *Hopea parviflora**, *Vitex altissima*, *Xylia xylocarpa*, *Salmalia malabarica*, *Glochidion* sp : *Macaranga peltata*, *Kingiodendron pinnatum*.

IIa. Heavy undergrowth of reed (*Ochlandra* sp.)*

General edaphic and seral types of semi-evergreen forests

E3—MOIST BAMBOO BRAKES

DESCRIPTION - More or less continuous cover of one or two species of tall clumped bamboos with occasional standard of *Terminalias* and other trees.

DISTRIBUTION - Locally throughout the semi-evergreen and moist deciduous types

LOCALITY FACTORS - The natural occurrence of bamboo brakes would appear to depend on soil conditions, and they favour stream sides and shady slopes but they have extended their territory very greatly as secondary associations.

FLORISTICS.

(ii) Nilambur, Kerala

I. *Terminalia crenulata**

IIa. *Bambusa arundinacea**

III. *Clerodendron viscosum*.

NOTE: The thorny bamboo, *Bambusa arundinacea*, is met with along stream throughout tropical India and often extends some distance up the slopes in sheltered localities (Kanara and Nilambur provide good examples). As it reaches maturity it forms giant clumps (upto 20 m. high) standing well apart on the ground

which carries very little else except a few smal shrubs. This thorny bamboo brake extends practically unchanged northwards into the northern moist deciduous forests, where also it has been much planted outside its natural range.

TYPE 2B/E4

E4—LATERITIC SEMI-EVERGREEN FOREST
NOMENCLATURE

Mysore - *Xylia* mixed forest (DAVIS)

Distribution - Occurs on lateritic soils in various parts of India particularly in the peninsular region extending upto S Bengal and is particularly characterised by the presence of *Xylia xylocarpa*.

Locality Factors - The climate is as for the main types but soil is usually derived from thick lateritic and is shallow and dry.

Florisics

I *Xylia xylocarpa** (va), *Pterocarpus marsupium** (f) *Anogeissus latifolia* (o), *Grewia tiliaefolia* (o), *Terminalia* spp., (f)

II *Careya arborea*, *Bridelia retusa*, *Calycopteris floribunda*, *Strychnos nux-vomica*, *Leea indica*.

III Generally sparse - *Adhatoda vasica*, *Holarrhena antidysenterica*,

2SI — SECONDARY MOIST BAMBOO BRAKES

DESCRIPTION - The thorny bamboo brake is identical in from throughout both northern and southern moist deciduous forests. It is sufficiently aggressive to be able to hold its own against tree growth though the latter probably gains ground after seed years, so that very gradually the bamboo ceases to dominate. The brakes of N. Bengal and Assam, which are formed by *Dendrocalamus hamiltonii* with its characteristic low spreading habit, also hold tenaciously to ground once occupied. Under a closed bamboo crop the floor is usually almost devoid of tree regeneration but scattered shurbs and thin grass may occur.

DISTRIBUTION - Locally throughout the moist deciduous forests.

LOCALITY FACTORS - As per the main type.

FLORISTICS

(i) Andamans

Oxytenanthera nigrociliata.

GROUP 3 TROPICAL MOIST DECIDUOUS FORESTS

Subgroup 3 A. Andamans moist deciduous forests

C1 — ANDAMANS MOIST DECIDUOUS FORESTS.

DESCRIPTION - There is typically a somewhat irregular top storey of predominantly deciduous trees about 40 m. or more in height, many of the trees being of very large girth and heavily buttressed. Beneath these trees is a rather definite second storey of numerous species including some evergreens, though most are deciduous, and there is a fairly complete shrubby evergreen undergrowth, including patches of bamboo. Climbers are heavy and often include canes.

DISTRIBUTION - Met with throughout the Andaman Islands covering nearly half their total area. There appears to be a limited area of similar forest in the Nicobars.

LOCALITY FACTORS - The climatic data given on pp. 82 to 85 for Port Blair are probably fairly representative. The under lying rock is chiefly rather hard coarse grained sandstone with bands of shale and conglomerate, any the soil which is often shallow, is a sandy or clayey loam of light yellowish colour. The type is confined to the hilly ground and does not extend much above 100 m. where it is displaced

by tropical evergreen not does it occur on the flat alluvial ground where the low evergreen forest described on p. 120-121 is inpossession.

FLORISTICS

(i) Andaman Is. (CHENGAPPA etc.)

I. *Pterocarpus dalbergioides** (S/D), *Terminalia bialata** (D), *T. manii**, *T. procera* (D), *Canarium euphyllum*, *Pterocymbium tinctorium* (E), *Salmalia insignis* (D), *Logerstroemia hypoleuca* (D), *Tetrameles nudiflora* (D), *Chukrasia tobularis* (S/D) *Albizzia lebbek* (D).

II *Lannea coramandelica*, *Adenanthera pavonia* (D), *Dillenia pentagyna*, *Diospyros marmorata* etc. (E), *Saccopetalum tectonum* (E), *Sageroea elliptica*, *Cratoxylon formosum*, *Semecarpus kurzii*, *Cinnamomum* spp., *Pterospermum aceroides*,

IIa. *Oxytenanthera nigrociliata*, *Bambusa schizostachyoides*.

IIIa. *Murraya paniculata*, *Atalantia monophylla*, *Pleiopermium alatum*, *Canthium gracilipes*, *Ixora grandifolia*,

IIIb, *Rinorea bengalensis*, *Mallotus acuminatus*, *Glycosmis pentaphylla*, *Licuala peltata*.

V. *Ventilago madraspatna*, *Delima sormentaosa*, *Harrisonia* spp., *Buttneria andamanensis*, *Acacia pennata*, *Entada phaseoloides*, *Calamus* spp.

NOTE - This type is unquestionably a stable preclimax to the tropical evergreen determined by the soil which is such that it dries out considerably in the period January-April in which but little rain falls. Although the forests have not until recently suffered from the hand of man, the planned management to which they are being subjected is unquestionably altering their character, the regenerated stands being more predominantly deciduous in character. It is possiple that this forest might in part be classified with the semi-evergreen.

(ii) Great Nicobar Is. (SAHNI)

*Terminalia procera**, *T bialata**, *Albizzia* spp. *Pterocymbium tinctorium*.

V. Climbers are numerous.

NOTE - This type occurs only in small strips along the coast and would appear to have edaphic climax status, evergreen and deciduous vegetation being very much mixed *Pterocarpus dalbergioides* is apparently absent.

TYPE 3A / CI / 2SI

C1/2SI — ANDAMANS SECONDARY MOIST DECIDUOUS FOREST

DESCRIPTION - A more or less evenaged pole crop.

DISTRIBUTION - Worked over areas of the primary type.

LOCALITY FACTORS - As for the primary type.

FLORISTICS

Andamans (regenerated area semi-evergreen type)
(BHARGAVA)

I. *Canarium euphyllum**, *Pterocymbium tinctorium**, *Salmalia insignis**, *Sideroxylon longepetiolatum*, *Tetrameles nudiflora*, *Terminalia bialata**, *Parishia insignis*,

II. *Pterocarpus dalbergioides** *Lagerstroemia hypoleuca**, *Terminalia manii**, *T. procera**, *Artocarpus chaplasha*, *A. lakoocha*, *Albizzia lebbek*, *Adenanthera pavonina*, *Planchonia anpamanica*, *Diploknema butryracea*. *Aphanamixis polystachya*.

Where the parent crop was semi-evergreen. the regenerated crop is more akin to moist deciduous with a lower proportion of padauk and evergreens partly as the result of sowing or broadcasting seed of deciduous species and burning. In moist deciduous types, the crop is essentially similar to the primary form. Two canapies are easily distinguishable, the top canopy consisting of fast-growing soft timber species, notably *Salmolia Pterocvmbium*, *Canarium* and *Terminalia bialata* (40% in all), whilst the lower canopy is composed of slower growing hardwoods such as *Pterocarpus*, *Lagerstroemia* and *Terminalia procera* (60% in all).

Comparison with the Andamans climax moist deciduous forest (3A/C1) shows the essential identity between the Primary and secondary forms, except for the composition of the emergent and lower layers and the consequent difference in structue on maturity.

Subgroup 3B. South Indian Moist deciduous forest

1. NOMENCLATURE

Maharashtra	Wet mixed deciduous forest. Moist deciduous forest (with and without teak) (Moist) teak forest.
Madhya pradesh	Monsoon forest. (Moist teak forest.
Mysore, Madras and Kerala	Moist deciduous forest. Monsoon forest,

2. GENERAL DESCRIPTION

Closed high forest commonly 30 - 36 m. or more in height the, dominant species being mostly deciduous though often only briefly so in comparison with the following types. Although intimate mixture of species is the rule, a relatively small number of species together form the greater part of the canopy and relatively pure associations are fairly frequently met with. Some evergreen dominants are included. but they are few; the evergreen habit is more developed in the lower storey giving the forest as a whole a more or less evergreen appearance most of the year.

A bamboo undergrowth is characteristic though locally absent, in which case the evergreens are commonly better developed. Canes are restricted to wet ground and epiphytes mostly to post climaxes in damp shady places; climbers are abundant and large. The undergrowth has usually been very greatly influenced by fires which traverse much of the type often maintaining it as a stable snb-climax to Group I or 2 though it would be recruited to some extent from Group 5 with fire protection.

The undisturbed soilc over would also consits mainly or more or less evergreen shurbs with but little, grass but the firees result in the sbread of the grass which often becomes heavy and continuous especially where the canpoy is open. The absence of small trees and saplings of the large tree species is often very marked and is also ascribable to repeated burning and grazing; teak seedings seem best adopted to survive these injuries.

The term 'monson forest' cannot resonably be restrictred to these types as it unduly stresses a pattern of precipitation which is a common feature of most of the type of vegetation occuring in India, espiecially Groups 3 and 5 and parts of 2 and 6,

The chief future of the moist deciduous forests is a leafless period in the dry season which may or may not begin with the cold weather but is typically most general in March-April when the upper canoby is almost entirely leafless though there is often a good sprinkling of evergreens

in the underwood and shrub cover. An appreciable number of the deciduous trees, however, come into new leaf (and often flower) long before the monsoon, unexpectedly spreading their new foliage at a time when one would expect them to experienee great difficulity in obtaining enough moisture for the intense transpiration which must take place. Teak drops its leaves early in the cold weather in localities which are relatively dry or cold but, is almost evergreen in the moistest parts of its distribution. *Cedrela toona* and *Dalbergia sissoo* come into new leaf in March-April and carry a full canopy all through the hot weather- *Terminalia tomentosa*, *Adina*, *Lannea* and many others gradually drop their foliage during the cold and dry seasons and do not leaf again till rain falls. Cold seems to prolong the leaflless seasons. *Hymenodictyon* is an example of trees with a long deciduous period lasting from November to June. Quite a number of species flower while more or less leafless, e. g , *Salmalia*, *Cassia fistuia*, *Sterculia* spp *Erythrina*, *Lannea* or as they come into leaf, e. g *Dalbergia sissoo* etc.

3. DISTRIBUTION

Moist deciduous forests occur in all parts India with medium rainfall, notably including the important moist teak bearing forests of India. Thus they are found all along the eastern side of W. Ghats.

Madhya Pradesh	Parts of Japalpur and Mandula and Rajpur Divisions.
Gujarat	Typi●al of the Dangs Division.

Maharashtra	Parts of Kolaba and Thana Divisions.
Mysore	Kanara, Mangalore and generallyin the western moister parts of the State.
Madras	South Coimbatore, Tirunelveli Divisions.
Kerala	Nilambur, Wynaad and generally where evergreen and semi-evergreen are absent.

4 LOCALITY FACTORS

Data are given in the table for forest selected localities covering the range under which this type of forest occurs, though as they are all outside the forests hardly one of them is a typical example.

TEMPERATURE - The mean temperature of the year varies from 24°C to 27°C and the mean maximum from 43°C in the relatively dry central parts of the penisula, to 35°C on the coast. The mean January temperature does not usually drop below 15,6°m though in the northern and most elevated localities it may fall a few degrees lower; the mean minimum shows a wide range from about 24°C on the coast in southern latitudes to 4.4°C in the continental north

RAINFALL AND HUMIDITY – Rainfall data for some of the stations of the last table and a few representative more typical localities for which tempetrature data are lacking are given in the table,

The first two stations are at the dry limit of the type, in fact very probably beyond it, the type occurring either as a post climax or in localities with better rainfall than the indicating station. At the opposite extreme come Nilambur and Trivandrum with the rainfall well distributed it is possible that in these localities the moist deciduous is only a fairly stable preclimax to semi-ever-green. Yellapur and Belgaum represent the wet and dry limits of the Central Western Ghats. It may be said that the typical rainfall for the type as a climax is 1500 to 2000 mm. with a dry season of 4-5 months; with a longer dry season the range extends to still higher rainfalls. As a stable preclimax with burning, the type predominates with much higher rainfalls even with very favourable distribution.

TEMPERATURE (CENTIGRADE)

TROPICAL MOIST DECIDUOUS FOREST

Month	Madhya Pradesh SEONI 615 m.			Madhya Pradesh JUBBULPORE 393 m.			Madhya Pradesh JUGDALPUR 553 m.			Maharashtra CHANDA 193 m.		
	Mean	Mean max	Mean min.	Mean	Mean max.	Mean min.	Mean	Mean max.	Mean min.	Mean	Mean max.	Mean min.
Jan.	18·6	26 0	11·1	17·1	25·2	8·8	18·9	27·7	10·2	21 3	29·6	13·0
Feb.	20·6	28·3	12·7	19·0	27 4	10 6	21·8	30·3	13·3	23·9	32·4	15·3
March	25 2	33·3	17·1	24·0	33·1	14·9	26·3	35 0	17 6	28·3	37·1	19·4
April	29 5	37·5	21·4	29·2	38·1	20·2	29 4	37·3	21·6	32·6	40·8	24·4
May	32 2	39·8	24·6	31·8	40·8	22·7	31·2	38·6	23·7	37·4	43·0	27·8
June	29·6	35·1	34·1	31·3	36·7	25 9	28·4	33·2	23 6	32 1	37·6	26·6
July	25·7	28·9	22·4	27·0	30·2	23·7	25·2	28·3	22·2	27·8	31·3	24 3
Aug.	25·1	28·2	21·9	26·2	29·2	23·1	25·1	28·3	21·8	27 4	30 7	24·0
Sept.	25 4	29·4	21·3	26·5	30·6	22·4	25·3	29·3	21·4	27·6	31·6	23·6
Oct.	24·1	30·2	17·8	24·3	31·0	17·5	24·2	29·4	18·9	26·1	32·1	20·1
Nov.	20·2	27·4	12·9	19·6	27·9	11·3	20·8	27·2	14·4	23·3	29·6	15·0
Dec.	17 9	25·4	10·3	16·6	25·1	8·1	17·9	26·0	9·8	19 8	28·1	11·6
M.A.T.	24·5			24·5			24·6			27·1		
Annnal mean max.	30 8			31·3			30·9			33·7		
Highest record	44·4			46 1			46·1			48.3		
Annual mean min.	18·2			17·6			18·2			20·4		
Lowest record	2·8			0·0			4·4			2·8		
No. of years	60			60			30			60		

Month	Maharashtra BOMBAY			Orissa KORAPUT			Mysore BELGAUM 780 m.			Kerala COCHIN 3 m.		
	Mean	Mean max.	Mean min.	Mean	Mean max.	Mean min.	Mean	Mean max.	Mean min.	Mean	Mean max.	Mean min.
Jan.	23·9	28 4	19·3	19·1	26·5	11·6	21·6	28·8	14·3	26·8	30·5	23·1
Feb.	24·1	28·4	19·7	22·3	29 0	15·5	23·2	31·3	15·2	27·4	30·6	24·2
March	26·2	31·1	22·2	24·9	31·8	18·0	25·9	34·2	17·6	28·3	31·1	25·6
April	28·1	31·7	24·5	27·1	33·5	20·6	27·1	34·0	20 2	28·7	31·4	25·9
May	29 7	32·8	26 4	26·6	32 0	21·2	21·1	34·0	20 0	28·3	30·8	25·7
June	28·7	31·4	25·9	26 8	31·2	22·3	23·9	27·6	20·2	26·5	29·0	23·9
July	27·2	29·7	24·6	23·1	25·8	20·2	22.1	24·6	29·7	25·9	28 1	23 7
Aug.	27·0	29·4	24·5	23·2	26·1	20·3	22·0	24·7	19·3	25 9	28 0	23·9
Sept.	27·0	29·7	24·3	23·1	26·2	20·1	22·6	26·3	18·7	26·2	28·3	24·1
Oct.	27·9	31·6	24·2	21·8	24·0	19·7	22·8	28 6	17 1	26·6	29·1	24·1
Nov.	27·2	31·9	22·5	18·1	21·3	14·8	23·3	28·2	16·4	26·9	29·8	24.1
Dec.	25·4	30·3	20·4	16·1	22·3	9·7	21·2	27·8	14·7	26·9	30·3	23·4
M.A.T.	26·8			22 7			23 5			27·1		
Annnal mean max.	30·4			27·5			29 3			29·8		
Highest record	38·3			...			40·6			33·9		
Annual mean min.	23·2			17·8			17 8			24·3		
Lowest record	11·7			...			6·7			17·8		
No. of years	60			Upto 1955			60 (to 1940)			60		

Month	Kerala TRIVANDUM 61 m.			Andaman is. PORTBLAIR 80 m.		
	Mean	Mean max.	Mean min.	Mean	Mean max.	Mean min.
Jan.	26 4	31·2	21 7	25·5	29·0	22·0
Feb.	27·6	31·9	23·2	25·6	29·7	21·4
March	28 5	32·7	24·3	26·4	30·8	21·9
April	28·6	32·3	24·9	27·7	31·7	23·7
May	29·3	32·8	25·8	27·2	30 4	23·9
June	27·1	30·5	23·8	26·5	29·1	23·9
July	26·3	29·4	23 2	26·4	28·8	23·9
Aug	26·4	29·5	23·3	26·2	28·6	23·7
Sept.	27·1	30 7	23 4	25·8	28·4	23·2
Oct.	26·8	30·4	23·1	26·0	28·8	23·2
Nov.	26 6	30·2	23·0	26·0	28·8	23·1
Dec.	26·2	30·4	22·0	25·7	28·7	22·7
M.A.T.	27·4			26·3		
Annnal mean max.	31 0			29·4		
Highest reeord	33·9			36·1		
Aunual mean min.	23·9			23·1		
Lowest record	18·9			16 7		
No. of years	60			60		

RAINFALL (MILLIMETERS)

TROPICAL MOIST DECIDUOUS FOREST

Month	Madhya Pradesh SEONI 615 m.	Madhya Pradesh JABBULPORE 393 m.	Madhya Pradesh JAGDALPUR 553 m.	Maharashtra CHANDA 193 m.	Maharashtra BOMBAY 11 m.	Mysore YELLAPUR 565 m.
	Rainfall mm,	Rainfall mm.	Rainfall mm.	Rainfall mm.	Rainfall mm.	Rainsall mm.
Jan.	14	21	10	8	4	2
Feb.	21	19	27	21	2	1
March	20	14	14	20	1	8
April	15	8	45	20	1	35
May	19	16	60	16	17	56
June	217	179	246	205	484	510
July	412	492	384	414	617	964
Aug.	338	431	414	320	340	555
Sept.	218	214	264	226	264	184
Oct.	58	48	111	52	65	136
Nov.	17	11	29	17	14	41
Dec.	13	9	4	7	2	7
Total for year (M.A.R)	1,363	1,462	1,607	1,324	1,809	2,498
No. of rainy days	70	65	83	63	74	105
No of months less than 60 mm.	7	8	6	7	6	6
M. A. Humidity	52	55	53	56	74	63
No. of years	60	60	30	60	60	?

Month	Orissa KORAPUT 911 m.	Mysore BELGAUM 780 m.	Kerala NILAMBUR 30 m.	Kerala COCHIN 3 m.	Kerala TRIVANDRUM 61 m.	Andaman Is. PORTBLAIR 80 m.
	Rainfall mm.	Rainfall mm.	Rainfall mm.	Rainfall mm.	Rainfall mm.	Rainfall mm.
Jan.	4	3	5	23	20	45
Feb.	8	1	4	20	19	28
March	19	10	13	51	39	28
April	36	45	67	25	116	60
May	62	58	152	297	223	384
June	213	206	671	723	335	562
July	417	434	871	592	197	392
Aug.	419	245	426	353	120	414
Sept.	274	122	194	195	115	442
Oct.	106	121	263	340	273	318
Nov.	33	39	118	170	177	267
Dec.	7	9	22	41	63	201
Total for year (M.A.R.)	1,597	1,294	2,805	2,929	1,697	3,143
No. of rainy days	87	81	115	130	97	150
No. of months less than 60 mm.	6	6	4	3	3	3
M. A. Humidity	?	66	?	79	80	81
No. of years	?	?	70	60	100	60

Rock and Soil - The type is found on practically very soil occuring in India within the tropics, From recent sandy alluvium to old red soil *in situ*. Although not attaining its best development on them, it occupies most of the pronouncedly lateritic soils, and it may be met with even on black cotton soils, though these are usually associated with a drier climate and so carry dry deciduous or thorn forest. Semi-evergreen forest will frequently be found on favourable sites and soils whilst near the drier climatic extreme, dry deciduous forest may be very intimately intermixed with it, occupying exposed aspects, dry ridges and shallow or impervious soils, With a climate appropriate to wet evergreen forest, this type may be predominate on rapidly drained slopes with porous soils.

Topography - The greater part of this forest type is on hilly ground, but this is mainly due to the destruction of the forest on the flatter culturable tracts.

5. GENERAL FLORISTICS

In the teak-bearing forests *Tectona grandis* is the most characteristic species independently of its economic importance and is of excellent development wherever the soil permits. In the top canopy it is generally associated with *Terminalia*, spp., *Pterocarpus* spp. and *Lagerstroemia* spp. *Adina* is often present though tending to indicate drier conditions, and *Dalbergia latifolia* is characteristic; *Xylia* is also very generally present, and *Schleiehera* and *Careya* are common, mainly in the second storey. The typical

bamboo is *Bambusa arundinacea*, *Dendroclamus strictus* only appearing at the dry end, as noted, howere, bamboos are not invariably pressnt. In the non- teak -bearing type a variety of moist and occasionally evergreen species occur in mixture.

6. SUBDIVISIONS, SUCCESSIONS, ETC

The type is veary uniform throughout its range, and the local variants appear to differ mainly owing to the different floras from which they are derived.

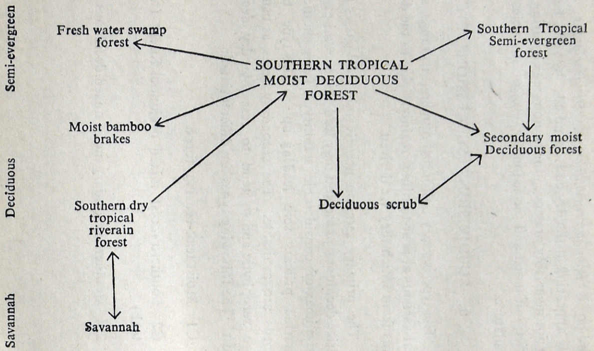
The primary sere on new riverain soils passes though a drier deciduous phase and may lead to a semi-evergreen post-climax of considerable stability. There should be an estuarine primary sere leading up to this type but no records are available. The secondary seres as usual are more xerophytic and so tend to resemble dry deciduous forest. The following types are differentiated:

C1 Moist teak-bearing forest.

C2 Southern moist mixed deciduous forest (without teak)

2SI Southern secondary moist mixed deciduous forest.

Successional relationships for Southern tropical Moist Deciduous forests



TYPE 3B/CI

CI-MOIST TEAK BEARING FORESTS

DESCRIPTION-A general description is given on p. 131-133. There are, however, significant floristic and environmental differences on the basis of which there sub-types can usefully be differentiated

CIa-VERY MOIST TEAK FOREST

Typical rainfall over 2,500 mm.; deep alluvial often clayey soils; low (upto 10) percentage of teak; very dense evergreen undergrowth; little natural regeneration; fires nil; gazing negligible,

CIb-MOIST TEAK FOREST

Typical rainfall 1,600 to 2,500 mm,; deep loamy soils fair to medium (10 to 25) percentage of teak; dense undergrowth; fair but patchy natural regeneration; fires rare; light grazing

CIc-SLIGHTLY MOIST TEAK FOREST

Typical rainfall 1,200 to 1,600 mm; moderately deed loamy soils; medium to high (20 to 60) percentage of teak; moderate undergrowth; fair natural regeneration; occasional fires: moderate grazing,

DISTRIBUTION-Met with throughout the Peninsula wherever the rainfall exceeds 1,300 mm. (except on the Karnatak Coast from the neighbourhood of Surat

and Hoshangabad southwards. Mainly found as a strip down the east side of the crest of the Ghats with outliers further east in Maharashtra and Madhya Pradesh (wel exemplified by the Bori forests below Pachmarhi and the Allapalli forests of S Chanda) and adjoining country.

LOCALITY FACTORS—AS indicated above.

TYPE 3B/Cla

Cla—VERY MOIST TEAK FOREST

The floristics correspond to the moister end of the moist deciduous, approaching the semi-evergreen. Site quality high, I to II: teak forming a low proportion of the overwood, usually not exceding 10%. Some of the forests are evidently of secondary origin on semi-evergreen sites, stabilished as a sub-climax. Characteristic species are the following:

I *Grewia tiliaefolia*, *Lagerstroemia lanceolata*.

II *Dillenia pentagyna*, *Kydia calycina*.

IIa. *Bambusa arundinacea* (o).

III. *Glycosmis pentaphylla*, *Clerodendrum viscosum*.

FLORISTICS

(i) *Muthodi, Bhadravathi Division, Mysore.*

I. *Terminalia crenulata** (a), *Grewia tiliaefolia** (o): *Dalbergia latifolia* (o), *Terminalia paniculata* (f)

T. belerica (f), *Tectona grandis** (f) *Logerstroemia lanceolata** *Dillenia pentagyna* (f), *Adina cordifolia* (f), *Pterocarpus maruspium* (f),

II. *Xylia xylocarpa* (la), *Kydia calycina* (f).

II a. *Bambusa arundinacea* (l a), *Denarocalamus strictus* (high quality), *Oxytenanthera monostigma* (lo).

III. *Clerodendrum viscosum*, *Leea* etc,

IV b, Grass is present whereever burning takes place.

V. *Butea parviflora* (f)

(ii) Begur, Manattoddy, Wynad, Kerala,

I, *Terminalia crenulata** (a) *Garuga pinnata* (o), *Salmalia malabarica* (o), *Tectona grandis** (f), *Grewia tiliaefolia** (f) *Lagerstroemia lanceolata** (f), *Stereospermum suaveolens* (f), *Dalbergia latifolia* (f), *Terminalia belerica* (l f), *Melia composita* (l f), etc.

II. *Emblica officinalis* (o), *Kydia calycina* [(f), *Wrightia* sp , (f) *Cordia dichotoma* (f) *Schleichera oleosa* (lf) etc.

IIa. *Bambusa arundinacea** (la).

III. *Lantana** (va), *Glycosmis pentaphylla* (lf), *Ardisia* sp. (lf)

IVb. Light grass.

V. *Dalbegia volubilis* (o) *Butea parviflora* (f) *Acacia pennata* (f).

NOTE : The forests have been frequently burnt in the past and much of the bigger teak has been worked out.

(iii) Mount Stuart, S. Coimbatore, Madras.

I: *Lagerstroemia lanceolata** (a), *Terminalia paniculata** (a), *Grewia tiliaefolia** (a), *Mitragyna parvifolia* (o), *Stereospermum personatum* (o), *Radermachera xylocarpa* (o), *Vitex altissima* (o) *Terminalia crenulata** (f), *Tectona grandis** (f), *Adina cordifolia* (f) *Dillenia pentagyna* (f); *Salmalia malabarica* (lo),

II. *Cycas circinalis* (o), *Emblica officinalis* (f), *Zizyphus xylopyrus* (f).

II a. *Bamhusa arundinacea** (c)

III. *Lantana** (va), *Helicteres* (a)

IVb *Imperata* (lf) and finer grasses

V *Convolvulaceae* (a), *Butea parviflora* (f) *Zyzyphus oenoplia* (f) *Caesalpinia mimosoides* (la).

NOTE : This forest immediately adjoins tropical evergreen and must in part be preclimax. It still gets burnt at intervels accounting for absence of evergreen undergrowth,

(iv) Trichur, Malayattur, Kerala.

I. *Adina cordifolia, Albizzia odoratissima, A. procera, Alstonia scholaris, Salmalia malabarica- Cedrela toona, Dalbergia latifolia Grewia tiliaefolia* Holoptelia integrifola, Hymenodictyon excelsum, Legerstroemia lenceolata* L. speciosa, Lannea coromandelica Miliusa velutina, Pterocarpus marsupium, Schleichera oleosa, Spondias pinnata, Radermachera xylocarpa, Tectona grandis,* terminalia belerica, T. paniculata*, T, tomentosa*, Vitex altissima, Xylia xylocarpa, Machilus macrantha.*

II. *Bauhinia malabarica. Bridelia retusa, Careya arborea, Cassia fistula, Dillenia pentagyna Erythrina stricta, Evodia lunu-ankenda, Ficus* spp. *Gmelina arborea. Macaranga peltata. Sterculia villosn, S. urens, Strychnos nux-vomica, Fagara bundrunga, Albizzia chinensis.*

II a. *Bambusa arundinacea, (Ochlandra* occurs occasionally),

III. *Calicarpa lanata. Clerodendrum viscosum, Cycas circinalis, Flueggea sp, Glycosmis pentaphylla, Helicteres isora, Hibiscus furcatus, Holarrhena antidysenterica, Lantana camara, Randia dumetorum, Urena lobata*

V. *Acacia intsia, A, pennata, Bauhinia vahlii, Caesalpinia bonduc, Calycopteris floribunda, Butea parviflora, Calamus* occur occasionally.

(v) Punalur, Thenmala, Kerala.

I. *Terminalia tomentosa*, T. paniculata*, T. bellerica, Stereospermum personatm, Dalbergia latifolia*, Pterocarpus marsupium*, Radermachera xylocarpa* Salmalia malabarica, Adina cordifolia, Hymenodictyon excelsum, Grewia tiliaefolia*, Lagerstroemia lanceolata, Xylia xylocarpa*, Tectona grandis*, Vitex altissima, Sterculia villosa' Lannea coromandelica.*

II, *Buchanania lanzan, Careya* arborrea, *Strychnos nuxvomica, Dillenia pentagyna, Semecarpus anacardium, Cycas circinalis, Miliusa velutina, Emblica officinalis, Ixora nigricans, Olea dioica, Mitragyna parvifolia, Cipadessa fruticosa, Aporosa lindleyana, Mallotus philippensis, Schleichera oleosa,*

IIa· *Bambusa arundinacea,*

III. *Helicteres isora, Clerodendrum viscosum, Leea,* sp., *Desmodium* sp., *Melanthesa* sp., *Zixyphus* sp. *Glycosmis pentaphylla, Eupatorium* sp. *Ixora cocccinea, Memecylon* sp., *Osbeckia* sp.

IVb. *Imperata cylindrica, Andropogon* sp., *Eragrostis* sp.

V. *Lautana camara, Acacia intsia, A. pennata Pterolobinm indicum, Caesalpinia mimosoides, Calpcopteris floribunda, Butea parviflora, Zizyphus oenoplia, Butea superba, Entada phaseoloides, Bauhinia vahlii*

TYPE 3B/Clb

Clb—MOIST TEAK FOREST

Deciduous associates predominate in this subtype. Teak is usually of II--III quality, forming a fair to medium proportion of the overwood. Some of the forest may be secondary in origin. Characteristic species are the following:

I. *Terminalia tomentosa. Dalbergia latifalia.*

II. *Xylia xylocarpa.*

IIa. *Bambusa arundinacea* (o), *Dendrocalamus srtictus* (a).

FLORISTICS

(i) Bori, Hoshnagabad Division, Madhya Pradesh,

I. *Tectona grandis** (a), *Terminalia tomentosa** (a) *Adina cordifolia* (a), *Pterocarpus marsupium* (f),

Dalbergia latifolia (o), *Lannea coromandelica* (f), *Lagerstroemia parviflora* (f), *Anogeissus, latifolia* (o), *Diospyros tomentosa* (o)

II. *Schleichera olesa* (o), *Ougeinia oojeinensis* (f), *Emblica officinalis* (f), *Miliusa tomentosa* (f), *Chloroxylon swietenia* (f), *Careya arborea*(o).

II a. *Dendrocalrmus strictus* (good quality la).

III. *Helicteres isora* (a), *Petalidium barlerioides Gymnosporia spinosa, Phoenix acaulis, Lantana camara*

IVa. *Triumfetta rotundifolia, Cassia tora.*

IV b. *Themeda quadrivalvis, Sorghum halepense, Dichanthium annulatum* etc.

V *Millettia auriculata* (a), *Cryptolepis buchannani* (o), *Bauhinia vahlii* (f), *Butea superba* (f), *Ventilago madrsaptana* (f), *Acacia Caesia* (o).

(ii) Allapalli, South Chanda Division, Maharashtra.

I. *Tectona grandis** (va) *Terminalia tomentosa** (f) *Adina cordifolia* ff), *Dalbergia latifolia** (f), *Madhuca indica* (f), *Lagerstroemia parviflora* (o), *Albizzia* spp, *Salmalia malabarica*, (o), *Diospyros tomentosa, Careya arborea,, Stereospermum personatum, Tamarindus indiea.*

II. *Xylia xylocarpa**, *Grewia tiliaefolia*, *Cleistanthus collinus*, *Emblica officinalis*, *Schleichera oleosa*, *Diospyros montana*, *Ixora arborea*.

II a. *Dendrocalamus strictus* (a)..

III. *Helicteres isora*, *Petalidium barlerioides*, *Pogostemon pelctranthoides*, *Indigofera* Spp.

IVa. *Achyranthes aspera*.

IVb. *Sorghum halepense* (in open) *Imperata cylindrica*, *Heteropogon contortus*.

V. *Bauhinia vahlii*, *Butea superba*, *Callicopteris floribunda*, *Acacia* spp., *Combretum decandrum*.

(iii). Dandeli, N. Kanara, Mysore.

I, *Terminalia paniculata** (a), *T. tomentosa** (a), *Logerstroemia lanceolata** (a), *Tectona grandis** (a), *Salmalia malabarica* (o), *Pterocarpus marsupium* (o), *Dalbergia latifolia* (f), *Dillenia pentagyna* (j), *Grewia tiliaefolia* (f), *Xylia xylocarpa** (f), *Bauhinia lawii* (lf).

II. Xylia xylocarpa (lf).

IIa *Dendrocalamus strictus* (a). *Bambusa arundinacea* (la), *Oxytenanthera monostigma* (lf).

III. *Lantana* (la).

V. *Acacia intsia** (a), *Mucuna prurita* (la).

(iv) Palghat, Kerala.

I. *Xylia xylocarpa**, *Terminalia paniculata**, *Anogeissus latifolia*, *Lagerstroemia lanceolata**, *Dalbergia latifolia**, *Albizzia odoratissima*, *A. lebbek*, *Salmalia malabarica*, *Pterocarpus marsupium*. *Kydia calycina*, *Lannea coromandelica*, *Terminalia tomentosa*, *Tectona grandis**, *Schleichera oleosa*.

II. *Wrightia tinctoria*, *Randia dumetorum*, *Mallotus philippensis*.

IIa. *Bambusa arundinacea*, *Dendrocalamus strictus*.

III. *Helicteres isora*, *Desmodium* sp., *Lantana*, *Eupatorium*.

TYPE 38/Clc

Clc — SLIGHTLY MOIST TEAK FORESTS

The proportion of dry deciduous associates is higher than in the last subtype, Site quality is III or lower; teak usually forms the major portion of the overwood. Characteristic species are the following :—

I. *Terminalia tomentosa*, *Adina cordifolia*.

II. *Schleichera oleosa*.

IIa. *Dendrocalamus strictus* (a).

FLORISTICS

(i) Bastar, Madhya Pradesh.

I. *Tectona grandis** (va), *Terminalia tomentosa* (a) *Adina cordifolia**, *Albizzia odoratissima*, *Salmalisa malabarica*, *Dalbergia paniculata*, *Diospyros tomentosa*.

II. *Syzygium cumini*. *Miliusa tomentosa*, *Careya arborea*, *Mitragyna parvifolia*.

IIa *Dendrocalamus strictus** (Va,)

III. *Ixora arbora*, *Clerdendrum viscosum*, *Lantana camara*, *Woodfordia fruticosa*, *Helicteres isora*.

IVb. *Imperata cylindrica*.

V. *Butea superba*, *Bauhinia vahlii*, *Combretum decandrum*, *Entada phaseoloides*, *Ichnocarpus frutescens*.

V. Betul, Madhya Pradesh (towards drier end).

I. *Tectona grandis** (va). *Terminalia tomentosa** (a), *Lagerstroemia parviflora* (f), *Adina cordifolia** (o), *Dalbergia latifolia* (lf), *Pterocarpus marsupium* (f), *Terminalia belerica* (o), *Anogeissus latifolia* (f), *Mitragyna parvifolia* (o), *Schrebera swietenioiles* (o)

II, *Schleichera olesa** (o), *Ougenia oojeinensis* (f) *Emblica officinalis* (o), *Miliusa tomentosa*, *Buchanania lanzan* (o), *Flacourtia indica* (f).

IIa. *Dendrocalamus strictus** (va),

III *Desmodium* sp. *Helicters isora* (f), *Gymnosporia spinosa* (lf) *Indigofera* (o), *Woodfordia fruticosa* (lf), *Barleria*, *Grewia* (f), *Nyctanthes arbor-tristis* (lf)

IVa. *Ageratum*, *Sida*, *Triumfetta*,

IVb. *Themeda quadrivalvis*, *Heteropogon*, *Ischaemum* spp.

V. *Millettia auriculata*, *Cryptolepis buchanani*, *Bauhinia vahlii*, *Butea superba*.

(iii) Chedleth and Sultan's Battery, Kerala.

I. *Terminalia tomentosa**, *Tectona grandis**, *Anogeissus latifolia** (mostly on the drier sites,), *Lagerstroemia lanceolata*, *Pterocarpus marsupium*, *Dalbergia latifolia*, *Adina cordifolia*, *Salmalia malabarica*, *Stereospermum personatum*.

II. *Schleichera oleosa*, *Kydia calycina**, *Albizzia odoratissima*, *Bridelia retusa*, *shorea talura*.

II a *Dendrocalamus ptrictus*.

III. *Wrightia tinctoria, Helicteres isora, Randia dumetorum, Allophyllus cobbe.*

V. *Acacia pennata, Butea parviflora.*

TYPE 3B/C2

C2—SOUTHERN MOIST MIXED DECIDUOUS FOREST

NOMENCLATURE—Moist deciduous teak bearing forest (Working Plans)

DESCRIPTION—The general description applies. The evergreen component is usually larger than in the case of the teak-bearing forests, except for the very moist sud-type. Teak is present occasionally and may be an indicator or secondary succession.

DISTRIBUTION—All along the western ghats and inland wherever the climate and soil are suitable.

LOCALITY FACTORS—Usually in damp valleys; occasionally on high ground with shallow or porous soils, the rainfall corresponding to the wetter types.

FLORISTICS

(i) Maharashtra (SATYANARAYAN)

I. *Tetrameles nudiflora, Stereospermum personatum, Dysoxylum binectariferum, Ficus nervosa* (all occasional.)

II-i. *Syzygium cumini** (35%), *Olea dioca** (18%), *Pouteria tomentosa*, *Bridelia retusa* var. *squamosa*, *Mangifera*, *Actinodaphne angustifolia*. *Ficus glomerata*.

II-ii. *Memecylon umbellatum*, *Mallotus*, *Ixora*, *Flacourtia*, *Randia*.

III. *Ballicarpa*, *Lasiosiphon*, *Phaylopsis*, *Leea*, *Pogostemon* etc.

IVb. *Grass generally absent.*

V. (Abundant) *Gnetum*, *Anodendron*, *Jasminum*, *Elaeagnus*, *Mezoneurum* etc.

(ii) Chanda, Maharashtra.

I. *Pterocarpus marsupium**, *Salmalia malabarica** (o), *Terminalia belerica* (o), *Anogeissus latifolia* (f), *Dalbergia latifolia* (o), *Terminalia tomentosa*, *Lannea coromandelica*, *Madhuca indica*, *Garuga pinnata*.

II. *Miliusa tomentosa* (a), *Polyalthia cerasoides** (a), *Lagerstroemia parviflora* (o), *Emblica officinalis* (f), *Xylia xylocarpa* (o to f), *Grewia tiliaefolia* (o), *Schrebera swietenioides* (f), *Cleistanthus collinus* (f), *Diospyros montana* (o), *Flacouria indica* (o).

II a. *Dendrocalamus strictus*,

III, *Zizyphus oenoplia, Casearia graveloens (a) Helicteres isora, Desmodium gangeticum.*

IVb. Grasses present.

NOTE : Very similar forest occurs in Andhra Pradesh with *Terminalia tomentosa* predominating accompanied by *Pterocarpus* (f), *Adina* (lf). *Salmalia* (o) *Grewia* (f)

iii North Kanara, Mysore (ARORA)

I. *Adina cordifolia**, *Grewia tiliaefolia, Madhuca indica, Dillenia pentagyna, Cinnamomum* (o), *Litsea* (o), *Olea dioica* (o)

II. *Emblica officinalis, Xylia xylocarpa* etc.

II(a). *Bambusa arundinacca, Dendrocalamus strictus.*

III. *Tabernaemontana* etc.

V. *Zizyphus rugosa, Cylea, Acacia concinna.*

(iv) Kerala (ANSARI)

I. *Terminalia paniculata**, *T. tomentosa**, *T. belerica, Pterocarpus marsupium. Albizzia procera, Alstonia scholaris, Dillenia pentagyna, Bridelia retusa, Salmalia malabarica, Grewia, tiliaefolia.*

II *Xylia xylocarpa, Careya arborea, Callicarpa lanata, Cassia fistula, Strychnos nuxvomica.*

III. *Croton reticulatus, Anisomeles heyneana Carissa caradas.*

(v) Rahni Kerala.

I & II. *Terminalia paniculata*, T. tomentosa, Pterocarpns marsupium, Anogeissus latifolia, Careya arborea, Buchanania lanzan, Emblica officinails, Dillenia pentagvna, Salmalia insignis, Sterculia villosa, Albizzia odoratissima, Cassia fistula, Gmelina arborea, Tabernaemontana heyneana, Bauhinia malabarica, Wrightia tinctoria*

IVb. *Saccharum spontaneum.*

TYPE 3B/C2/2SI

C2/2SI—SOUTHERN SECONDARY MOIST MIXED DECIDUOUS FOREST

NOMENCLATURE—Usually included with the climax moist deciduous.

DISTRIBUTION—Moist deciduous forest is found over considerable areas which experience the climate appropriate to tropical evergreen or at least semi-evergreen forest, soil and configuration being insufficient to account for the

absence of the latter, and abrupt changes to it being encountered. This is conspicuous the whole length of the Western Ghats There can be little doubt but that these forests are of secondary origin, the climatic climax having been displaced by human action direct (shifting cultivation), or indirect (grazing and burning outwards from settlement).

Description: The forest is very similar to the climax moist deciduous but usually with few or no fine big trees and more of the soft quick growing species including figs. Scattered survivors of the primary forest are occasionally encountered especially in damp hollows. Whereas deciduous shrubs and thin grass from the ground cover with annual burning, fire protection results in the development of a dense evergreen undergrowth in which the deciduous trees cannot regenerate.

Locality Factors — Very usually hilly ground, with the climate of the semi-evergreen or evergreen forests though the soil is often shallow and stony through past exposure and erosion Lateritic outcrops are frequently met with

Floristics

(i) *Parappa, S. Mangalore Division*

I. *Terminalia paniculata** (a), *Salmalia malabarica* (o), *Mangifera indica* (o), *Dalbergia latifolia* (o), *Adina* (o), *Lagerstroemia lanceolata* (o) *Terminalia crenulata* (f), *Dillenia pentagyna* (f), *Schleichera oleosa* (f), *Alstonia scholaris* (f) *Xylia xylocarpa* (la),

II *Olea dioica** (a), *Holarrhena* (o), *Careya arborea* (o), *Enblica officinails* (o), *Feronia limonia* (o), *Mallotus phillippensis* (f), *Strychnos* sp., (f) *Callicarpa arborea* (la) etc.

IIa. No bamboo.

III. *Clerodendrum viscosum* (a), *Helicteres* (f), *Glycosmis* (la).

V. *Calycopteris* (a) *Accacia intsia* (f), *Wegatea* (f).

NOTE : The evergreen undergrowth extending from damp spots includes *Actinodaphne*, *Psychotria*, *Webera*, *Ixora* and *Strobilanthes* spp. The most degenerate parts with either very shallow soil or hard vesicular laterite are definitely of a dry deciduous type: and appear unlikely to improve in any reasonable period of time.

(ii) Konnoth, Kerala (CHANDRASEKARAN)

I, *Terminalia paniculata**, *Xylia xylocarpa**, *Grewia tiliaefolia*, *Salmalia malabarica*, *Dalbergia sissoides*, *Terminalia bellerica*, *T. tomentosa*, *Albizzia odorotissima*, *Artocarpus hirsuta**, *Hopea parviflora*, Teak occurs very sporadially.

II. *Lannea coromandelica*, *Schleichera oleosa*, *Careya arborea*, *Dillenia pentagyna*, *Evodia lunu-ankenda*, *Erythrina* sp, *Gmelina arborea*, *Wrightia tinctotia*,

TYPE 3/EI

3/EI — *TERMINALIA TOMENTOSA* FOREST

Nomenclature - The name is taken from the marked predominance of *Terminalia tomentosa*, but this species occurs and may even predominate locally under a wide range of conditions in most forms of deciduous forest.

Description - Typically closed forest of good height and development with a lower storey tree canopy of smaller trees and a shrubby undergrowth which (if not burnt) has little grass except in water logged openings.

Distribution - Throughout the sal region on heavy or wel soils and so usually in valleys and hollows and on clayey alluvial patches.

Locality Factors - The heavy soil is characteristic, In this moist deciduous type the soil is moisture retentive and good growth is usual, in contrast with adjoining dry deciduous types in which also *Terminalia tomentosa* may predominater From the sites occupied, frost is fairly frequent.

Floristics

(iii) Sitanadi, S. Raipur Division Madhya Pradesh.

I. *Terminalia tomentosa**, *T. bellerica*, *T. arjuna* (by water side only) *Mitragyna parvifolia*,

Adina cordifolia, Pterocarpus marsupium, Schleichera oleosa, Syzygium cumini, Guruga pinnata. Grewia tiliaefolia, Dalbergia paniculata.

II. *Ougeinia oojeinensis, Syzygium cumini, Cleistanthus collinus.*

III. Shrub growth.

IVb. No grass.

V. *Bauhinia vahlii Butea superba.*

NOTE ; This type should be seral but from the sites occupied in narrow valleys, among the hills, forms atleast a very stable sub-climax, Compare however TROUP

IIa. *Bambusa arundinacea.*

III. *Glycosmis pentaphylla, Helictes isora, Desmodium* sp., *Leea indica.*

(iii) Nilambur, Kerala.

I. *Terminalia paniculata**, *Xylia xylocarba, Lagerstroemia lanceolata**, *Terminalia tomentosa, Tectona grandis, Dalbergia latifolia, Grewia tiliaefolia. Adina cordifolia, Pterocarpus marsupium, Anogeissus latifolia, Tetrameles nudiflora, Canarium strictum,* etc.

II. *Dillenia pentagyna, Careya arborea, Trewia nudiflora. Mallotus phillippensis' Ficus* sp. etc.

IIa. *Bambusa arundinacea, Oxytenanthera monostigma.*

III. *Clerodendrum viscosum. Helicteres isora, Glycosmis pentaphylla* etc.

GROUP 4. LITTORAL AND SWAMY FORESTS

Subgroup 4 A. Littoral forests

LI—LITTORAL FOREST

NOMENCLATURE— The terms beach and dune forest are in general use.

DESCRIPTION- The most characteristic species is the tall evergreen but very light foliaged *Casuarina* which often forms an almost pure fringe on sandy beaches and dunes along the sea face: in the Andamans *Manilkara littoralis* takes its place. Scattered smaller evergreen trees occur with fewer deciduous trees and these in the absence of *Casuarina* from the dominant canopy. There are numerous shrubs, and where the undergrowth is light, maritime grasses (*Spinifex*, etc,) and surface creepers are conspicuous, binding the sand. In the depressions, (which are swampy usually with saline water) the tidal species are poorly developed with a dense undergrowth; if the water fresher tall grasses (*Phragmites*) *occur*.

DISTRIBUTION - All round the coast wherever a fair width of sandy beach occurs, including sandy bars on the sea face of the river deltas.

LOCALITY FACTORS - The habitat is an exposed one with pronounced characteristics. The soil is sea sand often blown aud accumulating in low dunes, with adequate lime from shell fragments but poor in nitrogen and mineral

nutrients. It is very coarse, porous, and dry at the surface, but the water table is usually only a few feet down; the water is fresher than might at first be expected, but often brackish. Strong winds, often salt laden, act as dessicating agents with strong insulation and radiation from the bare sand rendering conditions pronouncedly xerophytic. The temperature is moderated by the proximity of the sea and by sea breezes Rainfall varies with locality from 760 mm. to over 500 mm. its influence is mainly seen in the rate at which the formation progresses towards the climate climax. The Indian coast line all lies within the tropics.

Temparature - No data are available from within the littoral forest but the four stations selected are in the near vicinity and except Madras are only a few metres above sea level.

TEMPERATURE (CENTIGRADE)

LITTORAL FORESTS

Month	Orissa PURI			Madras MADRAS			Madras TUTICORIN			Mysore KARWAR		
	Mean	Mean max.	Mean min.	Mean	Mean max.	Mean min.	Mean	Mean max.	Mean min.	Mean	Mean max.	Mean min.
Jan.	22·2	26 7	17·6	24·6	29·6	19·5	25·1	27·7	22·3	25·8	31·8	19·7
Feb.	24·4	28·3	20·6	25·8	31·3	20·2	25·7	28·2	23·1	25·5	30·6	20·3
March	27·9	30·2	25·6	27·7	33·0	22·4	27·1	29 6	24 7	26·7	30·9	22·4
April	28·6	30·9	26·2	30·4	35·3	25·6	31·4	37·1	25 7	27·8	31·3	24·4
May	29 6	32·0	27·3	33·1	38·5	27·6	30·5	34·5	26·4	28·7	31·4	25·9
June	29·4	31·7	27·2	32·4	37·6	27·3	31·0	35·4	26 6	26 2	28·3	24·0
July	28·7	30·7	26·7	31·0	35·7	26·3	30.3	34·1	26 6	25·8	27 7	24 0
Aug.	28·7	30·9	26·4	30·4	34·9	25·8	30·3	34·2	26·4	25 6	27 4	23·8
Sept.	29·0	31·4	26·5	29·8	34·4	25·1	29·3	32·9	25·8	26 4	28·9	23·9
Oct.	27·9	30 8	25·0	28·1	32·3	23·9	29·1	32·8	25·3	26·7	29·6	23·8
Nov.	24·9	29·2	20·7	25·9	29·7	22·2	26·7	29·7	23·6	25·4	31·1	19·7
Dec.	21·9	26·9	16 9	24·7	28·9	20·5	24·4	27·4	21·5	25·2	31·3	19·1
M.A.T.	26·9			28·7			28·4			26·3		
Annual mean max.	30.4			33 4			31·9			30·0		
Highest record	39·4			45·0			?			?		
Annual mean min.	23·9			23·9			24 8			22·6		
Lowest record	10 6			13·9			?			?		
No. of years	50			60			Upto 1955			Upto 1955		

Rainfall — As precipitation is in no way a limiting factor for this type, a wide range of rainfall is found as shown in the appended table.

RAINFALL (MILLIMETERS)

LITTORAL FORESTS

Month	Orissa PURI 6 m.	Madras MADRAS 20 m.	Madras TUTICORIN 4 m.	Mysore KARWAR 4 m.	Gujerat PORBUNDAR 5 m.
January	12	36	26	1	3
February	27	10	25	1	3
March	17	7	29	0	2
April	18	16	43	12	—
May	71	26	21	86	5
June	208	47	5	951	113
July	300	91	4	944	210
August	301	116	6	542	95
September	248	119	16	276	31
October	169	306	141	147	7
November	63	355	183	42	8
December	5	138	85	6	3
Total for year (M. A. R.)	1,438	1,268	582	3,006	479
No. of rainy days	67	57	29	104	24
No. of months less than 50 mm.	5	6	9	6	9
M. A. Humidity	78	72	69	80	—
No. of years	50	60	71	57	—

FLORISTICS - (CHENGAPPA)

(i) Andamans

I. *Manilkara littoralis**

II. *Pongamia pinnata, Morinda citrifolia, Erythrina variegata* var, *Orientalis, Calophyllum inoph yleum. Terminalia catappa, Barringtonia asiatica Cordia subcordata.*

IIIa. *Thespesia populnea, Hibiscus tiliaceus, Pandanus tectorius,*

IVa. *Ipomoea pes-caprae, Crinum asiaticum, Vigna retusa, Scaevola frutescens.*

V. *Mucuna gigantea, Colubrina asiatica, Caesal, pinia bonduc.*

NOTE : Lining the top of the beach are *Scaevola frutes cens* or a fringe of *Hibiscus tiliaceus* with *Colubrina asiatica, Smythea calpicarpa, Crinum asiaticum, Caesalpinia bonduc, Desmodium umbellatum, Mucuna gigantea, Clerodendrum inerme* and less frequently *Dalbergia tamarindifolia:* again there may be only *Pandanus tectorius* thickets, Above the beaches, the twining *Ipomoea pes-caprae, Vigna retusa Clitoria ternatea* may occur. On the west coast, *Tourneforia argentea. Pemphis acidula, Sophora tomentoa* are also seen,

Behind the shrubs, in adition to species noted in the description, *Guettarda Speciosa*, *Ixora brunnescens*, *Cycas rumphii*, *Hernandia peltata*, *Heritiera littoralis* and *Gyrocarpus jacqunii* may also occur (after PARKINSON).

(ii) Great Nicobar Islands (SBHNI)

I. *Casuarina equisetifolia**, *Calophyllum inophyllum*, *Terminalia catappa*.

II. *Barringtonia asiatica*, *Erythrina variegata* *Guettarda speciosa*, *Pongamia pinnata*, *Heritiera littoralis*, *Cerbera manghas*, *Ochrosia oppositifolia*.

III. *Ixora* spp, *Cycas rumphii*, Epi. *Asplenium nidus* *Dendrobium* sp , *Bulbophyllum*,

GENERAL NOTE:

Apart from the deltas, the type is very stable, only the flora described being able to presist in the loose blown sand, but where aecretion is taking place the sand may get fixed, acquiring some humus and becoming more loamy, and hardy colonisits of the adjoining floras come in *Borassus* and *Phoenix* are often to be seen behind the recently fixed dunes in the drier regions whilst coconut is planted in the moister climates.

Subgroup 4B Tidal Swamp Forests

General Description - Tidal forests vary somuch in. such short distances that a general description is difficult. The finest forest is found on ground which is flooded at every high tide with only moderately brackish water, and is an evergreen closed high forest 30m. or more in height of *Heritiera* or less commonly *Bruguiera*. There may be an underwood of younger trees of the same species or of others such as *Ceriops*, two storeyed forest being of ommon occurrence owing to the prevalence of trees whose maximum high is only 5-10m. mixed with others capable of further development The soil in these forest is typically bare mud, particularly in the best *Heritiera* though masses of regeneration may cover it locally. At higher levels flooded only at spring tides, there is more and more varied undergrowth of *Pandanus*, canes, ferns, etc and if very brackish, much *Pnoenix paludosa*. Nearer the sea with definitely salt water, the *Heritiera*, is replaced by the *Rhizophoraceae* and other smaller trees which colonise the mud banks and flats. Species are here relatively few and mostly occur gregariously; practically all are evergreen simble coriaceous leaves. Grasses are rare *(Oryza)*, Climber are usually few though *Derris* is locally abundant. Epiphytes are fairly numerous (notably the tuberous *Hydnophytum*). Some species, particularly among the *Rhizophoraceae*, grow on stilt roots and others send up knees (Heritiera) or pointed pneumatophores (*Sonneratia*, *Carapa*, *Amoora)* whilst *Litsea* sp. has long bifurcating aerial roots, Vivipary is characteristic of the

Rhizophora spp., and nearly all seeds or fruits are large but lighter than water, even in famalies (*Meliaceae)* in which winged seeds are usual. (*Sonneratia* is exceptional with minute seeds). BLATTER (1905) has given some biological notes on the Bombay mangroves, CURTIS' working Plan (1931-51) gives a good account of the Sunderbans forests.

Distribution — Of the large and important area carrying tidal forests in the delta of the Ganges and Brahmaputra rivers, only the poorer part west of the Raimangal branch now falls within India CURTIS' Working Plain gives a detailed stockmap for each compartment showing the distribution of the chief species with density and height.

There is considerable area under mangroves in the months of the creeks and short rivers. There are also remnants at the estuaries of the Mahanadi, Krishna and Godavari rivers on the East Coast, but very little in the creeks on the West Coast.

LOCALITY FACTORS-

Temperature: Mean annual temperature is very close to 27°C eqully on the Ganges and Godavari esturaries as on the Andamans and West Coast Creeks. The range is small, mean maximum being approximately 30°C at all stations and the mean minimum 20°C to 24°C. Data are given for Khulna, Kakinada (Godavari mouth), Port Blair in the Andamans and Calicut on the West Coast.

TEMPERATURE (CENTIGRADE)

TIDAL SWAMP FORESTS

Month	Andaman Islands PORT BLAIR 80 m.			West Bengal CALCUTTA 6 m.			Andhra Pradesh KAKINADA 8 m.			Kerala CALICUT 8 m			Maharashtra BOMBAY 11 m.		
	Mean	Mean max.	Mean min.	Mean	Mean max.	Mean min.	Mean	Mean max	Mean min.	Mean	Mean max	Mean min.	Mean	Mean max.	Mean min.
Jan.	25·5	29·0	22·0	29·5	26·4	12·6	23·2	27·3	29·1	26·3	31·1	21·6	23·9	28·4	19·3
Feb.	25·6	29·7	21·4	22·0	28·7	15·2	25·4	29·8	20·9	27·1	31·4	22·8	24·1	28·4	19·7
March	26·4	30·8	21·9	27·1	33·6	20·4	28·2	33·2	23·1	28·4	32·3	24·5	26·2	30·1	22·2
April	27·7	31·7	23·7	30·1	36·0	24·2	30·7	35·6	25·8	29·3	32·8	25·8	28·1	31·7	24·5
May	27·2	30·4	23·9	30·3	35·3	25·3	32·5	37·3	27·6	29·0	32·3	25·7	29·7	32·8	26·4
June	26·5	29·1	23·9	29·7	33·6	25·9	31·6	36·0	27·2	26·6	29·3	23·9	28·7	31·4	25·9
July	26·4	28·8	23·9	28·7	31·9	25·9	29.1	32·4	25·8	25·7	28·0	23·4	27·2	29·7	24·6
Aug.	26·2	28·6	23·7	28·7	31·7	25·7	28·9	32·1	25·7	25·9	28·3	23·5	27·0	29·4	24·5
Sept.	25·8	28·4	23·2	28·9	32·2	25·6	28·9	32·1	25·6	26·4	29·1	23·7	27·0	29·7	24·3
Oct.	26·0	28·8	23·2	27·5	31·8	23·2	27·7	31·1	24·4	27·0	30·2	23.8	27·9	31·6	24·2
Nov.	26·0	28·8	23·1	23·3	29·0	17·6	25·2	28·4	22·0	27·0	30·7	23·2	27·2	31·9	22·5
Dec.	25·7	28·7	22·7	19·6	26·3	12·8	23·1	26·9	19.1	26·4	30·9	21·8	25·4	30·3	20·4
M.A.T.	26·3			26·3			27·9			27·1			26·8		
Annual mean max.	29.4			31·4			31·8			30·6			30·4		
Highest record	36·1			42·2			47·2			37·2			38·3		
Annual mean min.	23·1			21·2			23·9			23·7			23·2		
Lowest record	16·7			6·7			13·9			16·1			11·7		
No. of years	60			60			60			60			60 (to 1940)		

Rainfall — The rainfall varies greatly without much influence on the vegetation. The West Coast and the Andamans get a high rainfall of over 3,000 mm. whilst the Ganges delta receives about 1,730 mm. and the East Coast only 1,000 mm. Below 260 mm. rainfall is received on the western Saurashtra Coast. Humidity is correspondingly high at 80% in the former pair and lower, about 73% in the eastern region.

TEMPERATURE (MILLIMETERS)

TIDAL SWAMP FORESTS

Month	Andaman Islands PORT BLAIR 80 m.	West Bengal CALCUTTA 6 m.	Andhra Pradesh KAKINADA 8 m.	Andhra Pradesh MASULIPATNAM
January	45	9	7	5
February	28	30	8	14
March	28	35	12	11
April	60	45	16	18
May	384	140	39	34
June	562	297	119	107
July	392	325	166	162
August	414	328	141	159
September	442	253	157	62
October	318	114	216	218
November	267	21	142	147
December	201	5	18	17
Total for year	3,143	1,600	1,042	1,053
No. of rainy days	150	84	56	55
No. of months less than 50 mm.	3	6	6	6
M. A. Humidity	81	74	73	74
No. of years	60	60	50	60

Month	Kerala TRIVANDRUM	Kerala CALICUT 8 m.	Maharashtra BOMBAY 11 m.	Gujerat PORBUNDAR 5 m,
January	20	9	4	3
February	19	5	2	3
March	39	17	1	2
April	115	91	1	—
May	223	236	17	5
June	335	840	484	113
July	197	825	617	210
August	120	436	340	95
September	115	202	264	31
October	273	261	65	7
November	177	139	14	8
December	63	26	2	3
Total for year	1,697	3,085	1,089	479
No. of rainy days	97	115	74	24
No. of months less than 50 mm.	3	4	7	9
M. A. Humidity	80	80	74	?
No. of years	100	60	60	53

Topography - A maze of tidal creeks the banks of which tend to be higher than the intermediate ground and so to from depressions in and out of which the tide flows daily, submerging the surface twice daily at one extreme and only at the highest spring tides at the other extreme. When the rivers are in spate, their water is banked up at high tide increasing the depth and reducing the salinity.

Soil - Entirely river-borne silt, a very fine mud being loamy where the water is fresh and stiff clay where it is alt, locally with some overlying sand (sometimes blown, sometimes deposited by water).

General Floristics - *Rhizophoraceae* are almost confined to the type, and are almost typical through absent or inconspicuous over much of the upper levels, their special habitat is the newly deposited mud banks submerged by the tides every day. In addition there are a few genera, each usually with several species, belonging to a considerable number of families which are specially adopted to the unusual conditions, thus *Sterculiaceae* (*Heritiera*) . *Meliaceae (Carpa)*, *Lythraceae (Sonneratia)*, *Verbenaceae (Avicennia) Euphorbiaceae Excoeearia, Apocynaceae* (*Cerbera*,) *Leguminosae* (*Cynometra*). Shrubs as opposed to small trees are few, *Acanthus* being the commonest, whilst the fern *Acrostichum aureum* is very typical. Palms are similarly limited to a few species notably *Phoenix paludosa* and *Nipa uticans.* Actually the flora is a poor one and exceptionally

uniform and widespread. Grasses are commonly absent, but *Oryza coarctata* is an early colonist where the water is fairly fresh. Studies have been made comparing the mangrove floras of the main occurrences showing the East Coast to be the richest in species (BLATTER et. al)

SUBDIVISION. SUCCESSIONS, ETC.

The following types are recognized:-

TSI-Mangrove scrub.

TS2-Mangrove forest

TS3-Saltwater mixed forest (*Heritiera*).

TS4-Brackish water mixed forest (*Heritiera*)

E1-Palm swamp.

Note-In the simplest case, there is evidently a succession from the mangrove scrub to forest and then through salt water to brackish water mixed forest as soil deposition prograsses From this stage there is often retrogression to rather drier types with monsoon flooding only and ultimately to the climatic climax which though varying very greatly even to thorn scrub in the Indus, is very generally a from of tropical evergreen. WAHEED KHAN (1957) has given a usefull summary of information and views on the ecology of the tidal forests

The succession of vegetation with respect to tidal influence is illustrated below for the Lower Godavari delta

Bed level		Neap high tide level		Normal high tide level		Spring high tide level		Equinoxial high tide level
	Avicennia marina		*Avicennia officinalis*				*Thespesia populnea* *Tamarix gallica*	
	Avicennia alba		*Sonneratia apetala* *Rhizophora mucronata* *R. candelaria* *Bruguiera conjugata* *B. cylindrica* *Ceriops roxburghiana*		*Excoecaria agallocha* *Lumnitzera racemosa* *(Aegiceras corniculata)*		*(Saline Banks)* *(Sueda maritima)* ↓ *(Cynodon dactylon)* ↓ *Aegiceras corniculata* *Excoecaria agallocha* *Lumnitzera racemosa*	

TYPE 4B/TS1

TS1 — MANGROVE SCRUB

NOMENCLATURE - Saltwater forests (CURTIS)

DESCRIPTION - More or less dense forest of very low average height, often only 3-6m. high. Often further reduced by biotic agencies, species few and markedly gregarious; all evergreen with entire leathery leaves Vivipary usual.

DISTRIBUTION - In the river deltas along the edge of tidal waterways and on sheltered muddy coasts from Gujarat round to Bengal. It occupies a large proportion of the Western Sunderbans.

LOCALITY FACTORS - Soft tidal mud submerged by salt water at every tide In the W. Sunderbans new silt is not being brought down by the rivers but is derived from the scouring of the land surface causing extensive depressions.

FLORISTICS

(ii) Salsette Island, Bombay (PATIL)

I/II. *Avicennia alba**, *Sonneratia apetala*, *Excoecaria*, *Aegiceras*, *Avicennia officinalis*,

III. *Acanthus ilicifolius*.

NOTE ; With increasing pressure of biotic factors, the vegetation is progressively reduced to a low cover almost exclusively of *Avicennia alba* and *Acanthus*.

(iii) Krishna and Godavari deltas.

*Avicennia officinalis**, *A. marina**, *Excoecaria agallocha**. *and Lumnitzera racemosa* from 90% of the stock.

TYPE 4B/TS2

TS2—MANGROVE FOREST

DESCRIPTION - Typically a closed evergreen forest of moderate height composed of trees specially adapted to survive on tidal mud which is permanently wet with salt water and submerged every tide. Stilt roots are very typical (notably in *Rhizophora)*, so also are leathery entire leaves and vivipary

DISTRIBUTION - In the river deltas along the edge of the delt streams, the tails of islands, and over- more extensive areas near the sea face wherever accretion is in progress. It does not develop on the sandy banks at the sea face. for though some young growth may be found, it passess on to other types without full development in the present one. The ground is flooded daily by salt water and never has time to dry out.

FLORISTICS

(ii) Krishna and Godavari deltas. (A. A. KHAN)

I/II. *Avicennia officinalis**, *Rhizophora mucronata** *R. bandelaria.*, *Ceriops roxburghiana** *Bruguiera* spp., *Sonneratia apetata.*

III. *Acanthus ilicifolius*, *Clerodendrum inereme*,

V. *Dalbergia spinosa*, *Derris trifoliata*'

NOTE : As `the ground level rises *Excoearia* and *Lumnitzera* take over.

(iv) Andaman Islands (CHENGAPPA)

*Rhizophora mucronata**, *R candelaria* (outer edge), *Bruguiera conjugata**, *B perviflora* (Just behind), *Avicennia officinalis*, *Ceriops tagal**, *Kandelia candel*, *Xylocarpus molluccensis*, *Sonneratia caseolaris*, *Excoecarla*, etc,,

(v) Great Nicobar Island. (SAHNI)

*Bruguiera conjugata**, *Carallia brachiata*, *Sonneratia caseolaris*. *Nipa fruticans*, *Areca triandra*

GENERAL NOTE

The soil deposition occuring in this type is mainly the product of erosion higher in the deltar The type appears stable over long periods but most gradually pass into the *Heritiera* as the level is raised unless changes result in fresh erosion or deposition of sand. The *Rhizophoras* and *Sonneratia* from lowest outermost frings and other species mentioned are rather behind and above and probably represent the next seral stage.

TYPE 4B/TS3

TS3 — SALTWATER MIXED FOREST (*Heritiera*)

NOMENCLATURE - Moderately salt water forests (CURTIS).

DESCRIPTION - The forest is fairly denee - it may even be denser than the fresh water type next to be described but is never high, rarely over 20m. nor do the trees attain large girths. The species are fairly numerous but tend to occur gregariously. Stilt roots are infrequent but pneumatophores typical.

DISTRIBUTION - In the bigger river deltas behind and beyond the foregoing type

LOCALITY FACTORS - The type occurs where the ground is flooded every tide with definitely brakish water. There is less silt deposition than in the freshwater type and so the soil has less humus and is less loamy, stiffer clay liable to crack extensively if exposed.

TYPE 4B/TS4

TS4 — BRACKISH WATER MIXED FOREST (*Heritiera*)

NOMENCLATURE - Fresh water forests (CURTIS)

DESCRIPTION - This is the finest development of the tidal forests and may be a closed forest over 33m. high

(*Bruguiera and Heritiera*) but it is poorly represented in the western part of the Sunderbans. Stilt roots are rarely met with but pneumatophores are usual (both general mentioned).

DISTRIBUTION - In the larger deltas, notably the Ganges.

LOCALITY FACTORS - The type occupies the levels which are flooded for some portion of each day, the water never being very salt and during the rainy season either quite fresh or only slightly brackish. There is a good deposit of fresh silt each year, It is best developed on the ground lying between the drier banks of the larger streams and the central depressions ("*bils*" in the Sunderbans.)

FLORISTICS

(ii) Andaman Islands. (CHENGAPPA)

I/II. *Heritiera littoralis**, *Barringtonia racemosa*, *B. asiatica*,

III, *Brownlowia lanceolata*, *Acanthu* spp.

IV. *Phoenix paludosa*, *Nipa*

TYPE 4B/EI

E1 — PALM SWAMP

DESCRIPTION - A dense low growth of tufted palms upto 6 m high.

Distribution - On the drier areas within the salt water mangrove scrub or forest.

Locality Factors - As above

Floristics

Phoenix paludosa.

TYPE 4C/FSI

Subgroup 4C. Tropical freshwater Swamp forests

FSI—MYRISTICA SWAMP FOREST

Nomenclature - *Myristica* swamps (KRISHNA-MOORTHY).

Description - Fairly dense evergreen closed forest about 15-30 m. high, with clean s'ender boles standing in mud through which aboundant knee roots protrude. There is little undergrowth, mainly *Aroids)* and *Scitaminae*.

Distribution - Restricted to valleys in the tropical evergreen forests of Travancore, Kerala.

Locality Factors - As fringing forest to sluggish streams below 300 m. altitude. Soil sandy alluvium with high humus content, often over kaolin clay derived from underlying gneissic rock. Inundated June to January and continuously wet or moist the rest of the year.

FLORISTICS - (KRISHNAMOORTHY)

I/II. *Myristica magnifica**, (va), *M laurifolia* (o), *M. canarica* (f), *M. malabarica* (o), *Lagerstroemia speciosa* (f), *Lophopetalum wightianum* (o), *Eugenia montana* (o), *Carallia brachiata* (o)

III. *Pandamus* sp.,

IV. *Aroidae*, *Cyperaceae*, *Scitaminae*,

V. *Calamus* sp.

NOTE : This localised but interesting type recently described from Kerala is being rapidly destroyed for conversion into paddy fields

Similar forest is recorded from New Guinea (WOMERSLEY, 1957).

TYPE 4C FS2

FS2 — TROPICAL HILL VALLEY SWAMP FORESTS

DESCRIPTION - Irregular forests of a limited number of mainly evergreen species able to withstand the wetness of the sites occupied The trees are usually low- crowned and branchy and there is often a dense growth of *Calamus*, whilst *Ficus* and monocotyledons such as *Alpinia* often form the undergrowth.

DISTRIBUTION - In suitable sites all along the Himalayan ub-montane tract and in tropical hill valleys though most of it has been cleared and drained for agriculture.

LOCALITY FACTORS - As compared with the preceding type the water is moving and persumably well aerated. The stream beds are usually gravelly and the silt and sand in which the trees are rooted are usually richly humic. The site is continuously wet or at least moist.

FLORISTICS

(i) Near Gudalur, Nilgiri, Wynad, Kerala.

I. *Eugenia**, spp. (a), *Mallotus alba** (a).

III. *Pandanus* sp. (a).

IV. *Alpinia* spp. (va).

NOTE : Narrow strips only.

(ii) Near Manantoddy, Wynad Division, Kerala.

I. *Anthocephalus cadambu** (a). *Machilus macrantha* (a), *Elaeocarpus tuberculatus** (f).

III. *Pandanus* sp. (a)

IV. *Alpinia* sp (va).

NOTE : These forms with *Pandanus* and *Alpinia* are very typical of the narrow swampy hollows in the W. Ghats.

Subgroup 4E — Tropical riparian fringing forests

RSI — RIPARIAN FRINGING FOREST

DESCRIPTION - A few species of large trees typically forming a rather narrow fringe along the water courses

sometimes spreading out along the rivers. These trees may be evergreen or deciduous but are usually sub-evergreen. They stand widely spaced with smaller trees and shurbs between and often much coarse grass. Examples are *Bischofia javanica, Terminalia arjuna, T. myriocarpa, Lagerstoemia speciosa*.

DISTRIBUTION - Along the banks of most of the largest streams in the hilly tracts.

LOCALITY FACTORS - Ample water supplies are available hough the soil may be coarse and non-retentive. The soil is typically sandy; it may be silty but is rarely clayey. It is liable to erosion and temporary flooding, but is normally well drained.

FLORISTICS

(i) Central India
*Terminalia arjuna**

(ii) Assam, Mysore.
*Lagerstroemia speciosa**

GENERAL NOTE ;

The type is maintained by the constant erosion and redeposition of soil going on along the rivers. In S. India the form described as Dry tropical riverain is more characteristic, but adequate descriptions are wanting.

DRY TROPICLAL FORESTS

GROUP 5 - TROPICAL DRY DECIDUOUS FORESTS

Subgroup 5A - Southern Tropical Dry Deciduous forests

1. NOMENCLATURE

The following terms have been used forests comprised this group :

Maharastra

Dry deciduous forest (Working Plans)
Savannah forest (TALBOT)
Teak pole forest (Working Plans)
Hardwickia forest (Working Plans)

Madhya Pradesh and Andhra Pradesh

Dry mixed forest with teak (Working Plans)
Dry mixed forest without teak (Working Plans)

Madras and Mysore

Dry mixed deciduous forests
Red sanders forest
Sandal bearing scrub forest

2. GENERAL DESCRIPTION

The upper canopy in the climax type is a closed though usually rather uneven and not very dense one. It is formed by a mixture of trees practically all of which are deciduous during the dry season, usually for several months though some for a short period only. Most of the species also occur in the moist deciduous forest where they reach finer development, the height of the dry deciduous forest being typically 13—20 m. The number of species is much less than in the foregoing types and although a few tend to predominate over any selected area, the majority are not particularly gregarious so that more or less pure associations can usually be traced to soil pecularities or human interferance. At the same time the dry deciduous forests provide the clearest examples in tropical India outside the sal forest of naturol single species crops The lower canopy is likewise almost entirely deciduous as although evergreens or sub-evergreen are present they are inconspicuous and mainly confined to the moister and more sheltered spots. An undergrowth of shrubs is usually present but enough light gets in to permit of more or less grass growth and with burning this tends to become more strongly developed resulting in savannah or park like forms. Bamboos are often present but are not luxuriant. Canes and palms are absent. Climbers are comparitively few but include large woody species which may be locally conspicuous, Epiphytes and ferns are quite inconspicuous.

3. DISTRIBUTION

The types is met with throughout the Indian Peninsula, with the exception of the W. Ghats where the rainfall exceeds 1,900 m. It merges into thorn forest wherever the rainfall drops below 750 m as in large tract to the lee of the W. Ghats. It is thus encountered in Madhya Pradesh, Gujarat. Maharastra, Andhra Pradesh, Mysore and Madras.

4. LOCALITY FACTORS

TEMPERATURE - Representative localities in the dry deciduous tracts in different parts of the country are included in the attached table. The annual mean maximum lies between 29°C and 35°C and the annaal mean minimum between 18°C and 23°C. The highest summer temperature may be as high as 48°C.

RAINFALL AND HUMIDITY - The typical annual rainfall for the type is 1,000 to 1,300 mm occasionally down to 850 mm. and frequently up to a much higher figure, say 1,900 mm. on dry soils or rapidly drained sites. A long dry season is experienced with little or no rain for about six months from November or December to April or May. and only unimportant showers till the break of the monsoon in June. The mean annual humidity varies considerably, 57 being a typical figure for Upper India, from anything down to 50 in C. India to figures well over 60 near the W Ghats, and lower Gangetic plain. Data are given for the same station as selected for the temperature table.

TEMPERATURE DATA (CENTIGRADE)

SOUTHERN TROPICAL DRY DECIDUOUS FORESTS

Month	Orissa SAMBALPUR			Madya Pradesh INDORE		
	148 m. mean	Mean max.	Mean min.	555 m. mean	Mean max.	Mean min.
Jan.	22·2	27·7	12·8	18·2	26·4	9·9
Feb.	22·7	30·2	15·2	19·8	28·4	11·3
March	27·4	35·4	19·3	24·6	33·4	15·7
April	31·7	39·4	30·8	29·3	37·6	21·0
May	34·4	41·4	27·3	32·0	39·4	24·6
June	31·7	36·4	26·9	29·8	35·3	24·3
July	27·9	30·7	25·1	26·1	29·5	22·7
Aug.	27·7	30·4	24·9	25·4	28·1	21·9
Sept.	28·2	31·5	24·9	25·4	27·7	21·1
Oct.	26·8	31·6	21·9	24·4	31·5	17·4
Nov.	22·6	28·8	16·3	20·7	28·8	12·6
Dec.	19·4	26·8	12·1	18 2	26·5	9·8
M. A. T.	26·7			24·4		
Annual mean max.	32·5			31·2		
Highest record	47·2			45·6		
Annual mean min.	20·9			17·7		
Lowest record	4·4			2·8		
No. of years	60			60 (to 1940)		

TEMPERATURE DATA (CENTIGRADE)

SOUTHERN TROPICAL DRY DECIDUOUS FORESTS

Month	Madya Pradesh JABBALPUR			Madya Pradesh RAIPUR		
	393 m. mean	Mean max.	Mean min.	296 m. mean	Mean max.	Mean min.
Jan.	17·1	25·2	8 8	20·4	27·6	13·2
Feb.	19·0	27·4	10 6	22·3	30·0	14·5
March	24·0	33·1	14·9	27·6	35·1	20·0
April	29·2	38·1	20.2	32 0	39·3	24·6
May	31·8	40·8	22 7	34·8	41·8	27·8
June	31·3	36·7	25.9	31·4	36·6	26·2
July	27·0	30·2	23·7	27·2	30·4	23·9
Aug.	26·2	29·2	23·1	26·8	29·9	23·8
Sept.	26·5	30·6	22·4	27·6	31·2	23·9
Oct.	24 3	31·0	17·5	26·2	31·4	20·9
Nov.	19 6	29·7	11·3	22·3	28.7	15·9
Dec.	16·6	25·1	8·1	19·6	26·7	12·5
M. A. T.	24·5			—		
Annual mean max.	31·3			32·4		
Highest record	46·1			42·7		
Annual mean min.	17 6			20·7		
Lowest record	—			3·9		
No. of years	60 (to 1940)			60 (to 1940)		

TEMPERATURE DATA (CENTIGRADE)

SOUTHERN TROPICAL DRY DECIDUOUS FORESTS

Month	Maharashtra DOHAD			Maharashtra NAGPUR		
	333 m. mean	Mean max.	Mean min.	312 m. mean	Mean max.	Mean min.
Jan.	20·1	28·9	11 1	21·5	28·7	14·6
Feb.	22 0	30·4	13·6	23·9	31·2	16 6
March	26·2	34·6	17·7	28 3	35·9	20 7
April	31·0	38·6	23·4	32·7	40·3	25·1
May	32·7	39·4	25·9	35·4	42·6	28·2
June	31·1	36·2	25 8	32·0	37 5	26·4
July	27·4	30·7	24·1	27·7	31·3	24·2
Aug.	26·6	29·6	23 8	27·3	30 7	23·9
Sept.	26 4	30·8	22·7	27·9	32·1	23·7
Oet.	26·6	33·8	19·4	26·7	32·8	20·6
Nov.	23·2	31·7	14·6	23·2	29·7	16·6
Dec.	20 4	29·1	11·7	20·8	27·6	14·8
M. A. T.	26·1			27·3		
Annual mean max.	32·8			34·4		
Highest record	45·0			47·8		
Annual mean min.	19·5			21·2		
Lowest record	—			3·9		
No. of years	10			60		

TEMPERATURE DATA (CENTIGRADE)

SOUTHERN TROPICAL DRY DECIDUOUS FORESTS

Month	Andhra Pradesh AURANGABAD			Andhra Pradesh WARRANGAL		
	303 m. mean	Mean max.	Mean min.	296 m. mean	Mean max.	Mean min.
Jan.	21·5	29·3	13·7	23·1	29·4	16·6
Feb.	23.4	31·4	15·3	25·4	31·9	18·8
March	27·4	37·5	19·4	28·7	37.6	21·8
April	30·8	32·5	23.2	31·6	25·2	25·1
May	31·1	39·7	24.3	33·9	40 3	27·6
June	28·7	34·6	22·8	31·3	36·3	26 4
July	25·8	30·0	21·6	27·7	31·2	24·3
Aug.	25 1	29·3	20·9	27·2	30·4	23·9
Sept.	25·4	30·1	20·7	27·7	31·2	23·6
Oct.	25 7	32·1	19·4	26·8	31·9	21·6
Nov.	22 9	30·1	15·7	23·7	29.6	17 8
Dec.	20·9	28·6	13·2	22·1	28·4	15·5

	AURANGABAD	WARRANGAL
M. A. T.	25·8	27·4
Annual mean max.	34·4	32·9
Highest record	45·6	46·7
Annual mean min.	19·2	21·9
Lowest record	2·2	8·3
No. of years	50	40

TEMPERATURE DATA (CENTIGRADE)

SOUTHERN TROPICAL DRY DECIDUOUS FORESTS

Month	Andhra Pradesh CUDDAPAH			Mysore BELGAUM		
	130 m. mean	Mean max.	Mean min.	780 m. mean	Mean max.	Mean min.
Jan.	24·9	31·2	18·7	21·6	28·8	14.3
Feb.	27 8	34·6	20·9	23·2	31·3	15 2
March	31·3	38·3	23·8	25·9	34 2	17·6
April	33 8	40·4	27·2	27 1	34·0	20·2
May	34·7	40 9	28 4	27·1	34·0	20·2
June	32·3	37·7	26·9	23·9	27 6	20·2
July	30·5	35·3	25·6	22 1	24·6	19·7
Aug.	30·1	34·8	25·3	22·0	24·7	19·3
Sept.	29·5	34·2	24·7	22·6	26·3	18·7
Oct.	27·9	32·1	23·6	22·8	28·6	17·1
Nov.	26 0	30·9	21·1	22·3	28·2	16·4
Dec.	24·4	30 0	18 7	21·2	27·8	14·7
M. A. T.	—			23·5		
Annual mean max.	35·2			29·3		
Highest record	46·1			40·6		
Annual mean min.	23·7			17·8		
Lowest record	11·7			6·7		
No. of years	60 (to 1940)			60 (to 1940)		

TEMPERATURE DATA (CENTIGRADE)

SOUTHERN TROPICAL DRY DECIDUOUS FORESTS

Month	Mysore BANGALORE			Madras SALEM		
	921 m. mean	Mean max.	Mean min.	278 m. mean	Mean max.	Mean min.
Jan.	20·4	26 8	14 1	24·8	31·2	18·3
Feb.	22·7	29·8	15·6	26·7	33·9	19·4
March	25·2	32·4	18·1	29 3	36·7	21 9
April	26·9	38·2	20·6	31·3	37·9	24·7
May	26 7	32·9	20·5	31·2	37·4	25·0
June	24·2	29·1	19 3	29·5	35 4	23·8
July	23·1	27·4	18·7	28·6	33·9	23·3
Aug.	23 1	27·4	18 7	28·2	33 5	22·9
Sept.	23·2	27·8	18·5	28·0	33·2	22·8
Oct.	22·9	27·6	18·3	27·2	32·1	22·2
Nov.	21·4	26·3	16·5	25 6	30·6	20.7
Dec.	20.1	25 7	16·6	23·6	28·4	18·8

	Bangalore	Salem
M. A. T.	23·3	27·9
Annual mean max.	28·9	33·8
Highest record	38·9	42·8
Annual mean min.	17·8	22·0
Lowest record	7.8	11·1
No. of years	60 (to 1940)	60

TEMPERATURE DATA (CENTIGRADE)

SOUTHERN TROPICAL DRY DECIDUOUS FORESTS

Month	Madras TRICHINOPOLY 78 m. mean	Mean max.	Mean min.
Jan.	25·4	30 7	20 1
Feb.	27·1	33·4	20·7
March	29 6	36·2	22·8
April	31 8	38·1	25·6
May	32.4	38·6	26·2
June	31·6	37·1	26·1
July	30·9	36·1	25·7
Aug.	30·4	35 8	25·1
Sept.	27·1	35·2	24·6
Oct.	28·4	33·0	23·7
Nov.	26·5	30·6	22·4
Dec.	25·3	29·9	20 9

M. A. T.	29·1
Annual mean max.	34·6
Highest record	43·9
Annual mean min.	23·7
Lowest record	13·9
No. of years	60 (to 1940)

RAIN FALL (MILLIMETRES)

SOUTHERN TROPICAL DRY DECIDUOUS FORESTS

Month	Orissa SAMBALPUR	M. P. INDORE	M. P. JABALPUR	M. P. RAIPUR
	148 m.	555 m.	393 m.	296 m.
Jan.	11	6	21	9
Feb.	24	4	19	22
March	22	2	14	18
April	15	3	8	16
May	27	13	16	23
June	256	147	179	230
July	522	283	492	381
Aug.	484	207	431	364
Sept.	230	164	214	195
Oct.	54	31	48	55
Nov.	21	16	11	14
Dec.	4	7	9	5
Total for year (M. A. R.)	1,670	882	1,462	1,332
No. of rainy days	74	47	65	64
No. of months with less than 60 mm.	7	8	8	7
M. A. Humidity	62	50	55	57
No. of years	50	—	—	—

RAIN FALL (MILLIMETRES)

SOUTHERN TROPICAL DRY DECIDUOUS FORESTS

Month	Maharashtra DOHAD 333 m.	Maharashtra NAGPUR 312 m.	A. P. AURAN-GABAD 306 m.	A. P. WARAN-GAL 269 m.
Jan.	2	9	7	10
Feb.	1	17	4	15
March	2	15	5	12
April	1	15	5	23
May	17	19	18	31
June	90	224	138	153
July	229	371	171	232
Aug.	176	290	122	177
Sept.	143	204	170	186
Oct.	36	55	46	66
Nov.	17	20	24	28
Dec.	20	12	7	6
Total for year (M.A.R.)	715	1,251	719	939
No. of rainy days	40	63	45	54
No. of months with less than 60 mm.	8	7	8	7
M. A. Humidity	69	51	48	56
No. of years	10	60	50	40

RAIN FALL (MILLIMETRES)

SOUTHERN TROPICAL DRY DECIDUOUS FORESTS

Month	A. P. CUDDA-PAH	Mysore BEL-GAUM	Mysore BANGA-LORE	Madras SALEM	Madras TIRUCH-RAPPALLI
	130 m.	780 m.	921 m.	278 m.	78 m.
Jan.	10	3	6	7	25
Feb	3	1	7	8	13
March	5	10	10	14	9
April	15	45	41	49	46
May	38	58	106	117	84
June	75	206	73	80	41
July	103	434	100	96	34
Aug.	133	245	127	167	97
Sept.	153	122	169	154	120
Oct.	123	121	149	164	183
Nov.	90	39	68	97	148
Dec.	21	9	11	26	71
Total for year (M. A. R.)	769	1,294	866	980	872
No. of rainy days	46	81	57	62	45
No. of months with less than 60 mm.	6	6	5	5	6
M. A. Humidity	58	66	65	62	60
No. of years	—	—	—	60	—

ROCK AND SOIL - The type is developed on virtually any variety of rock or soil, the latter being naturally dry most of the year. It is especially characteristic of sandy soils, and is often found on these even with a rainfall amply sufficient for the moist deciduous type. VAHID'S (1927) account of the correlation between geology and forest type of N Chando division of Maharashtra is a useful contribution to our understanding of this type.

TOPOGRAPHY - The greater part of the area under dry deciduous forest is undulating ground generally hills of low or medium height, but this is largly due to the fact the flat ground has been brought under cultivation except where pronouncedly unfavourable soil conditions have prevented it In C. India much of the tract occupied is on the plateaux at 450m, to 600m.

5. GENERAL FLORISTICS

The forest can be divided into classes according as teak is present or absent The most characteristic tree of the teak - bearing type is *Tectono grandis* and its most typical associates *Anogeissus latifolia* and *Terminalia.* The non-teak bearing forests, the dominant genera are again *Anogeissus* and *Terminalia* accompanied by *Diospyros Boswellia* and *Sterculia.* Representatives of many families are included among the codominants, their chief characteristic being perhaps thier wide distribution and general adaptability such that most are equally common in the cooler northern forest and in the moist deciduous types.

Dipterocarpaceae are virtually absent (only *Shorea talura* and *S. tumbuggaia* very locally.) The chief bamboo is *Dendrocalamus strictus*, The grasses are forms of medium height, *Heteropogon*, *Themeda*. *Saccharum Spontanum* etc., the tall tufted *Erianthus*, etc., not occuring.

6. SUB - DIVISONS, SUCCESSIONS, ETC.

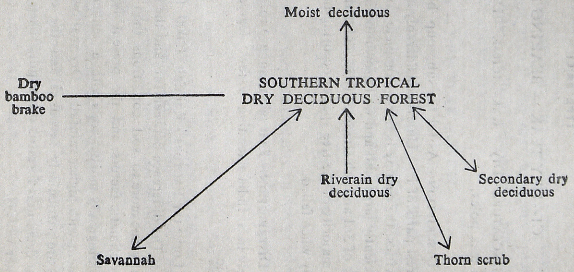
The following climax types are distinguished,

C1 — Dry teak bearing forest

C2 — Dry red sanders - bearing forest

C3 — Southern Dry mixed deciduous forest.

Successional relationships in Southern dry tropical forest



TYPE 5A/C1

C1—DRY TEAK — BEARING FOREST

NOMENCLATURE - Dry teak forest. Dry mixed forest with teak poles.

DESCRIPTION - As for the subgroup but excluding the poorest parts of it, Unless considerably affected by human activities, the canopy is fairly complete and the trees are sufficiently large, tall and well grown to yield sown timber Teak of 3rd and 4th site quality is indicative of the type. The majority of the tree species occuring in this type coppice freely when felled.

DISTRIBUTION - That of the subgroup. It is met with widely in S. India extending a few degrees north of the tropic.

LOCALITY FACTORS - Rainfall 1,000 to 1,250 (1,750) mm. The difference between this and the following type is usually due more to soil conditions than to rainfall and other climatic factors, and the present type occupies the physiologically moister soils with a tendency to be more frequent with higher rainfall, Dry shallow soils on hill-sides are particularly favoured and the change from the moist deciduous forest is often quite sharp as one leaves the moister valleys.

SUBDIVISION - The following subtypes are recognised:

C Ia — VERY DRY TEAK FOREST

Rainfall less than 900 mm.: dry infertile soils; teak in low to fair amount mixed with dry deciduous species: ground cover scanty; seedling regeneration practically absent; fires annual; grazing heavy.

C Ib — DRY TEAK FOREST

Rainfall 900 to 1,300 mm, shallow or porous of clayey soils; teak present in high ptoportion, sometimes practically pure: undergrowth high and patchy; seedling in groups and patches; fires frequent: grazing heavy.

C I a—VERY DRY TEAK FOREST

Very open forest of very poor quality on stony, detrital truncated and shallow soils, usually derived from crystalline rocks or trap.

Characteristic species with the *Tectona*, *Boswellia serrata*, *Anogeissus*, *latifolia*, *Sterculia urens*, *Cochlospermum religiosum*, *Acacia catcehu* and occasionally *Anogeissus pendula*, especially in transition zone to *Anogeissus pendueal* edaphic community,

(iii) Ajanta, Aurangabad Division. Maharastra.

I. *Tcctona grandis** (f) *Boswellia serrata** (f), *Sterculia urens* (lf), *Anogeissus latifolia** (a), *Delbergia latifolia** (a), *Lannea coromandelica* (f), *Salmalia malabarica* (o), *Azadirachta indica* (o) *Cordia dichotoma* (f).

II. *Terminalia tomentosa* (o), *Acaeia catechu** (a) *A. leucophloea* (f), *Hardwickia binata* (lf), *Zizyphus* spp., *Wrightia tinctoria*.

III. *Nyctanthes arbor-tristis* (a), *Lantana canara* (la), *Cymnosporia spinosa* (f) *Buphoria* sp. (lf)

SUBTYPE 5A/CIB

C Ib—DRY TEAK FOREST

Mixed dry deciduous forest with teak usually forming the major propertion of the crop on shallow porous or stiff clayey soils, Characteristic species are *Anogeissus latifolia*, *Diospyros tomentosa*, *Hardwickia binata* and other common dry deciduous trees.

FLORISTICS

(ii) Madya Pradesh (General floristica),

I/II. *Tectona grandis** (va), *Anogeissus latifolia** (a) *Diospyros tomentosa** (lf). *Pterocarpus marsupium* (o), *Dalbergia latifolia* (o), *Cassia fistula* (o). *Butea monosperma* (o), *Adina cordifolia* (o), *Mitragyna parvifolia* (o), *Bridelia retusa* (o), *Aegle marmelos* (o), *Lagerstoemia parviflora* (o), *Wrightia tinctoria* (o), *Bauhinia* spp., (o), *Alangium salvifolium* (o),

IIa. *Dendrocalamus strictus* (la,)

III. *Nyctanthes arbor-tristis* (la), (*Woodfordia fruticosa* (r), *Helicteres isora* (f), *Grewia hirsuta* (f), *Gymnosporia spinosa* (o), *Indigofera pulchella* (o), *Adhatoda vasica* (f), *Carissa* spp. (f), *Holarrhena antidysenterica* (f), *Lantana camara* (o).

IVa. *Cassia tora* (f), *Euphorbia* spp. (f), *Xanthium strumarium* (o).

IVb *Apluda mutica* (f) *Aristida* spp. (f), *Chloris inflata* (f), *Eragrostiella* spp. (f), *Iseilema laxum* (f), *Heteropogon contortus* (f), *Themeda quadrivalvis* (f), *Dichanthium annulatum* (f),

V. *Abrus precatorius* (f), *Acacia caesia* (f), *Acacia pennata* (f). *Combretum decandrum* (o), *Cryptolepis buchanani* (f), *Millettia auriculata* (o), *Tinospora cordifolia* (o), *Ventilago calyculata* (o), *Zizyphus oenoplia* (o)
Vanda (r) *Loranthus* (f), *Viscum* (r), *Cuscuta-reflexa* (o).

(ii) Indore & Kannod, Madhya Pradesh.

I. *Tectona grandis** (va), *Terminalia tomentosa** *Lannea coromandelica* (f), *Diospyros tomentosa** (f), *Madhuca indica* (f), *Miliusa tomentosa* (f). *Anogeissus latifolia** (f), *Soymida febrifuga* (o). *Mitragyna pnrvifolia* (o), *Boswellia serrata* (o), *Hardwickia binata** (o), *Dalbergia paniculata*. *Dilenia pentagyna*.

II. *Butea monosperma* (f) *Buchanania lanzan* (o), *Emblica officinalis* (o), *Cassia fistula* (o), *Acacia catechu*, *Baukina recemosa* (o), *Halarrhena antidysenterica* (lf), *Flacourtia indica* (o) *Randia dumetorum*.

IIa. *Dendrocalamus strictus* (lf).

III. *Helicteres isora* (f), *Calotropis gigantea* (o), *Grewia* sp., (o), *Woodfordia fruticosa* (lf), *Nyctanthes arbor-tristis* (f).

IVa. *Cassia tora* (f) *Ocimum* sp. (lf) m, *Xanthium strumarium* (lf).

IVb *Themeda quadrivalvis*, *Heteropogon contortus*, *Cymbopogon martini*, *Schima sulcatum*, *Iseilema*, *Saccharum spontaneum*, *Aristida* sp.

V. *Acacia caesia* (f), *Zizyphus oenoplia* (f), *Tinospora cordifolia* (o), *Abrus precatorius* (r).

(iii) Tenducbua N. Raipur, Division, Madhya Pradesh.

I/II. *Tectona grandis** (20-90%), *Terminalia tomentosa*, *Diospyros tomentosa,** *Anogeissus latifolia**, *Cleistanthus collinus*, *Pterocarpus marsupium*, *Adina cordifolia*, *Ougeinia oojeinensis* (o), *Dalbergia latifolia* (o)

IIa. *Dendrocalamus strictus* (a),

III. *Helicteres isora*, *Strobilanthes* sp., *Woodfordia fruticosa*.

IVb. *Themeda triandra*.

V. *Bauhinia vahlii*.

NOTE : The valley areas provide transitions towards moist deciduous forest but the slopes are typical. Rainfall about 1,500 mm. elavation 300 - 750 m.

(iv) Seoni Division, Madhya Pradesh (Medium quality teak forest, with bamboos).

I/II. *Tectona grandis** (40%), *Terminalia tomentosa*, *Diospros melanoxylon**, *Anogeissus latifolia**, *Lagerstroemia parviflora*. *Emblica officinalis*, *Lannea coromandelica*, *Ougenia oojeinensis* (l), *Pterocarpus marsupium* (o), *Dalbergia latifolia* (a).

II a. *Dendrocalamus strictus* (a) (impenetrable masses)

III. *Indigofera pulchella*, *Moghania* spp.

IV. *Milletia auriculata* (o). Climbers notcommon.

(i) Nirmal Division, Andhra Pradesh.

I. *Tectona grandis**, *Pterocarpus marsupium*, *Anogeissus latifolia**, *Dalbergia latifolia*, *Terminalia tomentosa*, *Chloroxylon sweitenia*, *Lannea coromandelica*, *Dulbergia paniculata*, *Salmalia mala-*

barica, Terminalia belerica, Madhuca indica, Lagerstroemia parviflora, Boswella serrara, Sterculia urens.*

II. *Diospyros tomentosa*, Buchanania lanzan, Acacia chundra, Acacia leucophloea, Aegle marmelos, Soymida febrifuga, Wrightia tinctoria, Butea monosperma, Cleistanthus collinus, Zizyphus xylopyrus.*

III. *Randia dumetorum, Cassia auriculata, Nyctanthes arbor-tristis, Helicteres isora, Zizyphus* spp.

(ii) Dharwar Taluka, Kanara, Mysore.

I/II. *Dillenia pentagyna, Kydia calycina, Terminalia* spp., *Lagerstroemia lanceolata, Adina cordifolia, Tectona grandis*, Anogeissus latifolia* Madhuca indica, Buchanania lanzan, Salmalia, Grewia tiliaefolia, Lannea coromandelica, Pterocarpus marsupium.*

IIa. *Dendrocalamus strictus, Bambusa arundinacea* (1).

III. *Lanatana, Santalum album, Dodonaea vicosa, Carrissa opaca*

(iii) Madras LEGRIS & VIART)

I. *Tectona grandis*, Anogeissus latifolia*, Pterocarpus marsupium, Emblica officinalis, Boswellia serraia*, Bridelia retusa;* occassional *Albizzia*

odoratissima, Terminalia tomentosa, T. bellerica, panliculata, Dalbergia paniculata, D. latifolia, Gmelina arborea, Holoptelea integrifolia.

II. *Chloroxylon swietenia, Diospyros motana, Hardwickia binata*, Premna tomentosa, Cassia fistula, Wrightia tinctoria, Acacia chundra, Atlantia monophylla, Canthium dicoccum, Soymida febrifuga.*

GENERAL NOTE:

The presence or absence of a single species is admittedly a poor basis for differentiation though an aggressive gregarious dominant such as *Shorea robusta* may reasonably be used in this way. The absence of teak in dry forest is often difficult to account for but in many instances intensification of the dryness of the locality physically or physiologically it deflnitely the cause, and in very general terms, the dry teak forest takes in the moister end of the present formation and the dry miscellaneous the dried end. An Interesting overlap of the northen Moist sal and the southern Dry teak (approching moist teak) as met with in N. Raipur division. M P., especially in the Gindola area There is also a Preservation Plot ("Centenary") at Sitadungri, Satpura Division, on sandstone with a mixed sal-teak crop but the sal is dry topped with epicormics

TYPE 5A/C2

C2—RED SANDERS BEARING FOREST

Description – As described for the subgroup except that *Petrocarpus santalinus* conspicuously predominates sometimes forming pure consociations over extensive areas, and teak is absent. The forests are all periodically burnt and so are rather open and with a heavy growth of grass.

Distribution - Cuddapah. Kurnool, Chittoor and Nellor divisions of Andhra Pradesh.

Locality Factors - On dry hilly often rocky ground usually on quartzite at 150 m. to 760 m. with 750 to 1000 mm. rainfall distributed as shawn for Cuddapah.

Floristics

(i) S.Cuddaph Division, Andhra Pradesh (P.P.3, 78 hect) 430m. on shale with some quartzite. gralelly soil.

I *Pterocarpus* santalinus*. (open).

II. Absent.

III Thorny shrubs.

IVb Grass.

(ii) S. Cuddapah Division, Andhra Pradesh.

I. *Pterocarpus santalinus**, *Anogeissus latifolia**, *Hardwickia binata Terminalia, cheblua, T. tomentosa*.

II. *Cnloroxylon swietenia**, *Erythroxylon monogynum**, *Randia dumetorum*, *Dolichandrone atrovirens Gardenia latifolia*, *G. gummifera* (dry slopes). *Buchanaia lanzan*.

III. *Grewia* spp., *Croton cabiosus*, *Gmelina asiatica Strobilanthes* sp. (in moist localities).

IV. *Heteropogon contortus Cymbopogon* spp.

NOTES: Apparently a climatic climax, though it disappears on the gneiss of the adjoining Chittoor division with but little change of climate. The retreating monsoon also brings rain so that the moistest months are July to October inclusive.

TYPE 5A/C3

C3—SOUTHERN DRY MIXED DECIDUOUS FOREST

DESCRIPTION- As for the subgroup and differing from the dry teak mainly floristically though some typical species (notably *Boswellia)* are more conspicuous. Thorny

plants occur and tend to increase in proportion with the heavy grazing, etc, to wich most of the area is subjected. Bamboos are often absent and usually of poor quality when present Grass is conspicuous till it is grazed down or burnt. Climbers are generally few, but may be heavy locally (*Bauhinia vahlii, Acacia* spp.)

Distribution - That of the subgroup, being especially prevalent in the drier localities and sites. It thus occurs throughout Peninsular India.

Locality Factors- Rainfall 875 to 1125 mm. on dry sites and soils. Shallow soiled well drained hill sides or undulating ground are typical and it is often difficult to decide whether the occurrence of the type is due to site or climate. The forests are mostly burnt annually.

General Floristics.- The most characteristic tree is *Anogeissus latifolia*, whilst *Terminalia tomentosa* is a very typical associate. *Diospyros tomentosa* is also common. *Chloroxylan swietenia, Hardwickia binata, Boswellia serrata* and *Soymida frebrifuga* are very widespread and usual indicators as they are absent from the moist deciduous forests, but their occurrence is rather sporadic and often traceable to soil factors. *Acacia catechu* is often present indicating the relation to thorn forests. The undergrowth is usually thin with a fairly dense growth of grass during the monsoon.

(i) Madhya Pradesh.

I/II. *Terminalia tomentosa** (f), *Anogeissus latifolia** (f), *Mitragyna parvifolia* (f), *Schrebera swietenioides* (o) *Madhuca indica* (lf), *Diospyros tomentosa* (la), *Buchanania lanzan* (o). *Lagerstroemia parviflora* (o), *Emblica officinalis* (o), *Cassia fistula* (o), *Santalum album* (la), *Albizzia* spp. (o), *Boswellia serrata* (o). *Chloroxylon swietenia* (la), *Syzygium cumini* (la), *Hardwickia binata* (la), *Acacia arabica* (r). *Prosopis juliflora* (r), *Sterculia urens* (r).

III. *Nyctanthes arbor-tristis* (lo), *Zizyphus* spp. (o), *Helictres isora* (f), *Vitex negundo* (la), *Adhatoda vasica* (f), *Gymnosporia spinosa* (o), *Randia dumetorum* (o), *Flacourtio indica* (o), *Grewia* spp. (o) *Woodfordia fruticosa* (o), *Balanite aegyptiaca* (o), *Carissa* spp. (o), *Holarrhena antidysenterica* (a), *Lantana camara* (o).

IV a. *Cassia tora* (f), *Achvranthes aspera* (f), *Abutilon* spp., (f), *Corchorus* spp. *Ocimum* spp., (r).

IVb *Apluda mutica* (f), *Aristida* spp., (f), *Iseilema laxum* (f), *Heteropogon contortus* (f), *Themeda quardrivalvis* (f), *Dichanthium anuulatum* (f).

(ii) Bhandara Division M.P.

I/II. *Terminalia tomentosa**, *Cleistanthus collinus**, *Lagerstroemia parviflora*, *Soymida febrifuga*,

Anogeissus latifolia, *Chloroxylon swietenia*, *Aegle marmelos*, *Emblica officinalis*, *Acacia catechu*, *Pterocarpus marsupium*, *Zizyphus xylopyrus*, *Ougeinia oojeinensis*, *Lannea coromandelica*.

IIa. *Dendrocalamus strictus* (hilly parts only).

III. *Gardenia resinifera*, *G. turgida Gymnosporia spinosa*. *Ixora arborea Nyctanthes arbor-tristis*, *Woodfordia fruticosa*, *Helicteres isora*, *Indigofera pulchella*.

IVb *Heteropogon contortus*, *Themeda triandra*, *Iseilema laxum* (l),

V Climbers a few, *Zizyphus oenoplia*, *Acacia pennata*, *Bauhinia vahlii*, *Olax scandens*.

NOTE : The bamboo is absent over all the flatter areas in which tree growth is poorer from human interference *Tesminalia tomentosa* and *Cleistanthus* predominate in closed canopy on the better sites, *Soymida febrifuga* predominates on poor dry calcareous and quartizitic soils especially as second growth.

(iv) Chirodi R. F. Andhra Pradesh.

I. *Terminalia tomentosa** (o), *Bauhinia racemosa* (f), *Acacia arabica* (o), *A. catechu* (f) *Boswellia serrata** (f), *Buchanania lanzan* (c), *Azadirachta indica* (o), *Ougeinia oojeinensis* (r), *Flacourtia indica* (r), (6-8 m. high.)

II. *Gymnosporia spinosa* (a), *Zizyphus mauratiana* (a) *Z. xylopyrus* (f), *Morinda tinctoria* (r),

III *Mimosa hamata* (a). *Terminalia tomentosa* (whippy seedings 3 m. high) (f), *Grewia hisuta* (f). (1 m high)

IVb. *Heteropogon contortus* and other low grasses.

NOTE : Formerly heavily grazed.

(vii) Cuddalore Nallamalais, S Kurnool Division AP.

I/II *Anogeissus latifolia** (40-89) *percent*), *Cleistanthus collinusl Terminalia tomentosa Pterocarpus marsupium*, *P. santalinus* (lo), *Hardwickia binata* (lo); *Tectona grandis* (lo);

IIa. *Dendrocalamus strictus.*

IIIa. Heavy grass growth.

(viii) S. Cuddapah Division A P.

I/II *Terminalia pallida*, *Shorea talura**, *S. tumbuggaia*, *Eugenia alternifolia*, *Mangifera indica*, *Albizzia odoratissima*.

III. *Phoenix acaulis*.

IVb. Heavy grass (annually burnt).

NOTE : This type forms a transition to, or may belong to the moist deciduous forests, occurring on higher slopes and plateaux over 600 m.

(ix) Dharwar Division, Mysore

I/II. *Acacia catechu, Anogeissus latifolia*, Terminalia* tomentosa, Soymida febrifuga, Chloroxylon swietenia, Albizzia amara, Cassia fistula, Melia azedarach, Hardwickia binata, Tectona grandis* (lo), *Santalum album.*

III. *Lantana*

IVb Fairly good growth of grass

(x) Anthargange Sample Plot, Bhadravathi Division, Mysore.

I. *Anogeissus latifolia** (a). *Terminalia chebula* (o), *Lagerstroemia parviflora* (o), *Terminalia tomentosa** (f), *T. paniculata* (f) *T, bellerica* (f), *Madhuca indica* (f), *Grewia tiliaefolia* (o), *Tectona* (o) *Dalbergia latifolia* (o) *Mitragyna parvifolia* (o), *Stereospermum personatum* (o), *Albizzia odoratissima* (o), A. *amara* (o). *Pterocapus marsupium* (o). *Schleichera* (o) *Stryehnos pottorunıɒ* (o), *Lannea* (o), *Diospyras montanu* (r), *Schrebera* (r). *Soymida* (if), *Dalbergia paniculata* (o), *Hymenodictyon**, (o), *Adina* (o) *Sterculia urens** (b), *Gmelina* (o),

GENERAL NOTE ;

In example (vii), (ix,) (x.) The patches in which teak is a prominent component of the crop could also be considered to belong to Dry teak 5A/C1.

II. *Zizyphus xyloprus* (a), *Randia dumetorum* (f), *Bauhinia racemosa* (o), *Ehretia laevis* (f), *Emblica officinalis* (f), *Gardenia latifolia* (f), *Flacourtia indica* (f), *Santalum* (o), *Diospyros melanoxylon* (o), *Butea monosperma* (o), *Cho-roxylon* (o).

IIa. *Dendrocalamus strictus* (la).

III *Holarrhena* (a), *Gardenia turgida* (o), *Randia uliginosa* (o), *Ixora arborea* (r), *Gardenia gummifera*.

IVb. A complete cover of short grass including some *Aristida*.

V. *Zizyphus oenoplia* (f). *Acacia intsia* (f), *Celas trus paniculata* (o)

NOTE: On hill slopes *Anogeissus latifolia* often strongly predominates forming nearly pure associations.

(xi) C. Salem Division, Madras,

I/II *Shorea talura**, *Dalbegia latifolia*, *Terminalis tomentosa*, *T. chebula*, *paniculata*, *Pterocarpua marsupium*, *Albizzia odoratissima*, *Anogeissus latifolia*, *Cassia fistula*, *Hardwickia binata*, *Santalum album*.

II a. *Dendrocalamus strictus*.

IVb. Good deal of grass.

NOTE; This form occurs at higher elevation, thorn scrub predominating lower down.

(xii) Anantapur Division, Madras (Miscellaneous pole forest).

I/II. *Hardwickia binata, Anogeissus latifolia**, *Chloroxylon swietenia, Erythroxylon monogynum, Acacia chundra.*

Degradation Stage of Dry Deciduous Forests

The following stages are recognised:

DSI - Dry deciduous scrub.

DS2 - Dry savannah forest.

DS3 - Euphorbia scrub.

DS4 - Dry grassland.

DSI—DRY DECIDUOUS SCRUBS

DESCRIPTION - A low broken soil cover of shrubby growth 3 to 6 m high including some tree species reduced to similar conditation, usually many stemmed from the base. Some bamboo is often present. Many of the shrubs are distasteful to cattle (*Holorraena, Dodonaea*) or throny

(*Randia, Carissa*). Thin grass occurs throughout. It is possible but not necessary to distinguish northern and southern forms

DISCRIPTION - Throughout the dry deciduous forest zone of India.

LOCALITY FACTORS - There may be localities in which the soil and climate are such as to permit of the development of a dry deciduous low forest in which tree growth in the narrower sense is scarce, but all examples examined seem unquestionably to owe their stunted condition to maltreatment, usually directly or indirectly connected with felling, lopping, grazing and frequent fires. Even dry teak forests may be reduced to this stage with many stemmed crooked branchy teak stocks (4 to 6 shoots), amidst *Zizyphus nummularia, Balanites or Salvadora* scrub near villages.

FLORISTICS

(vi) Digwal Hyderabad, Andhra Pradesh.

Gynmosporia * (a). *Dodonaea** (a), *Randia** (a), *Bauhinia racemosa* (a), *Buchanania lancifolia* (f). *Butea* (a), *Mimosa* (f), *Acacia cutechuoices* (f), *A. arabica* (o), *Zizyphus mauratiana* (f), *Ixora arborea* (f), *Anona squamosa*.

(vii) Mansurabad, Andhra Pradesh.

Scattered *Acacia leucopholea**, *Bauhinia racemosa Dalbergia paniculata, Wrightia tinctoria* Z[illegible]

xylopyrus, Cassia firtula, Randia Anona, Heteropogon contortus, Eragrostis* spp.

(viii) Mysore plateau.

Coppice shoots of dry deciduous forest species i. e.) *Tectona* (dry teak), *Pterocarpus Albizzia, Terminalia- Chioroxylon, Hardwickia* etc, with thorny species *Atlalantia monophylla, Flacourtia, Dichrostachys*. Aandia, Acacin chandra*.*

(ix) Southern Mysore Plateau.

Albizzia lebbek, A amara, Chloroxylon swietesnia, Acica, chundra, Azardirachta indica, Zizphus mauritana, Z. oenoplia, Dichrostachys cinerea*, Euphorbia antiquorum*, Pterolobium indicum,* in stonier places *Gyrocarpus jacquinii*, Sierculia urens, Cochlospermum religoisum, Commiphora caudata*, Givotia rottleriformis*: occasionally *Hardwickia, Feronia limonia, Commiphora, Givotia* and *Dendrocalamus strictns*

(x) Motebennur, Mysore.

Butea. Hardwickia, Cassia auriculata, Lantana*, Dodonaea*, Cymbopogon* spp.

GENERAL NOTE:

A considerable variety of degenerate forests could be included here but the above examples are fairly representative. Some of them are the

result of long continued maltreatment of which grzing and lopping may be the chief factors, or fuel and pole fellings may be equally influential. Others are regrowth after a period of cultivation and may have grown up under more or less heavy grazing. Savannah types with scattered bushes and low trees among grass are very common.

DS2 — DRY SAVANNAH FOREST

DISCRIPTION - The usual open but typical formation is lost and the trees stand far apart singly or in small groups in more or less heavy grass in which certain fire resistant plants persist, either slowly establishing themselves as trees, or sending up annual shoots from a woody rootstock. Stemless *Phoenix* is particularly characteristic. The trees have very short boles and are usually crooked and unsound or hollow. Thorny shrubs are common.

DISTRIBUTION-Throughout the dry deciduous forests.

LOCALITY FACTORS- Those of the general type combined with over exploitation, heavy grazing and usually annual burning.

FLORISTICS

(ii) Kalahandi, Orissa. Lateriete plateau at about 1,0000 m. (Mooney).

I/II. *Emblica officinalis** (c) *Bauhinia retusa, Dillenia, Cayeya, Elaeodendron,*

IVb *Arundinella setosa* (va), *Cymbopogon martinii* (a), *Themeda triandra* (a),

GENERAL NOTE :

This type occurs fairly extensively on the Central Indian hills at about 1,000 m.

(iii) Motebennur, Mysore.

I. *Hardwickia binata**, *Butea monosperma*.

III. *Cassia auriculata, Dodonea viscosa, Lantana camara,*

IVb. *Cymbogon* sp. (va).

(iv) Eastern Madras.

I. *Pterocarpus marsupium, Anogeissus latifolia*, Bridelia retusa, Terminalia chebula, Emblica, officinalis*

III. *Phaenix humilis**,

IVb. *Cympogon coloratus* (dominant)

NOTE : Further degradation leads to a form in which only a few *Pterocarpus*, *Bridelia* and *Emblica* stand over dense grass, mainly *Cymbopogon coloratus*, *Themeda triandra* and *Heteropogon contortus*, with aboundant *Phoenix humilis*.

(v) *SHOREA TALURA* savannah Madras.

*Shorea tabura**, *S. tumbuggaia**, *Pterocarpus santalinus*, *P. marsupium*, *Anogeissus latifolia*, *Diospyros melanoxylon*.

III. *Phoenix humilis*.

IVb Dense grass.

ECOLOGICAL STATUS :

Nearly all the climatic types described can be reduced to open savannah form. These types are showa as degradation stages consequent on Intense biotic interference as it is considered that the climatic climax has a more or less complete tree and shrub canopy with grass growth a definitely subordinate feature. The grass becomes conspicuous wherever the conopy is broken and is favoured against other forms of vegetation by burning, lopping and grazing. As the conditions which lead to the development of savannah forest render it more xerophytic than tropical forests approximate those of the dry tropical arers.

TYPE 5/DS3 & DS4

DS3 — *EUPHORBIA SCRUB*

This type is described under the Thorn forest of 6B/DS1.

DS4 DRY GRASSLAND

The dominant grass cover in the dry deciduous zone is *Schima - Dichanthium* type, the characteristic perennial species being.

(i) Hills and hill slopes.

Schima nervosum, Chrysopogon fulvus, Themeda triandra, Eremopogon foveolatus, Heteropogon contortus, Cymbopogon spp..

(ii) Plateau & vulleys, deep soils.

Dichanthium annulatum. Bothriochloa pertusa, Eremopogon foveolatus, Cynodon Dactylon.

Deteriorated grasslands are characterised by the presence of several annual species chiefly *Heteropogon contortus* (anuual form) A*ristida* spp., *Melanocenchris jacquaemontii, Eragrostis* spp, *Chloris* spp., *Alloteropsis cimicina, Andropogon pumilus, Urochlou panicoides* etc. The subcovers typical of degraded stages are six. *Cypogon (cf. DS2 page 253) Chrysopogon, Bothriochloa, Heteropogon, Eremopogon and Aristida, Eragrostis - Melanocenchris.*

EDAPHID CLIMAX TYPES IN DRY DECIDUOUS FORESTS

The following edaphic types are specifically recognized.

E1 - *Anogeissus pendula* forest.

DS1 - *Anogeissus pendula* scrub.

E2 - *Boswellia* forest

E3 - *Babul* forest

E4 - *Hardwickia* forest

E5 - *Butea* forest

E6 - *Aegle* forest

E7 - Laterite scrub forest

E8 - Saline-alkaline scrub Savannah.

E9- Dry Bamboo brakes.

GENERAL NOTE :

Many of the species of the mixed deciduous forests are capable of forming more or less pure consociations. This tendency is emphasized in the dry forests by the harsher environmental conditions climatic, edaphic and biotic, to which the forest is usually subject, so that greater demands are made on the specific adaptability of constituent elements leading to pure groups to local dominance. Among species forming such consociation in addition to *Anogeissus pendula Boswellia serrata, Butea monosperma Hardwickia binata. Aegle marmelos, Phoenix sylvestris, Salvadora, Acacia arabica* treated in greater detail as distinct edaphic climaxes the following may be mentioned, being undoubt_ edly of edapho-biotic status although details are lacking.

Xylia Xolocarpa Pterocarpus marsupium (moister) facies *Diospyros tomentosa, Terminalia chebula Anogeissus latifolia Cleistanthus Collinus* (dry facies).

Acacia senegal, Albizzia amara, Cochlospermum religiosam (very dry facies).

TYPE 5/EI

El — *ANOGEISSUS PENDULA* FORESTS

DESCRIPTION - The type is largely determined by the presence of *Anogeissus pendula* which forms nearly pure crops, often quite well stocked about 6m. high and 70-80 cm girth, but branched from about 1 to 1 5 m. above ground. The associated species are those of the southern dry deciduous type with more and more of the thorn forest species as the habitat is drier- The forest is leafless from March to June. There is a thin shrub and grass undergrowth but no bamboo.

DISTRIBUTON - Aravali hills in Rajaputana, Ajmer-Merwara Bandulkhand, northwards to Jhansi and south wards to the Narmada in Nimar and Panch Mahals TROUP.

LOCALITY FACTORS - Temperature and rainfall. The climate is typically hot as far representative stations in Uttar Pradesh and Rajasthan. There are great extrems of temperature. The rainfall may be as low as 400 mm. or as high as 950 mm.

Soil and topography, The type usually occurs on the lower and gentler slopes and tops of low hills. *Boswellia* or *Sterculia urens* occupying the higher ridges on crests) within

the 240-600 m. altitudinal range The rock is crystalline or metamorphic or sandstone, rarely limestone. The soil is gravelly reddish loam, rather shallow, more clayey on lower reaches and level ground.

FLORISTICS

GENERAL : It generally forms pure or markedly gregarious associations, the common associates being *Acacia leucopholea* and *A. senegal* in the western part of the range.

Edaphic Climax Types in Dry Deciduous Forests

EI/DSI — ANOGEISSUS PENDULA SCRUB

When browsing pressure is heavy, especially by goats, the *Anogeissus* is reduced to spreading and creeping forms sometime forming ptostrate cushions looking like topiory work. This is the last stage of degradation before it is totally eleminated.

E2— *BOSWELLIA* forest

DESCRIPTION - An open forest in which *Boswellia* forms an overwood to stunted trees and shrubs of dry deciduous forests. Sometimes almost pure consociations of well grown mature trees or pole crops occur, especially on the flatter tops of Satpura range. It is ordinary 12-15 m. [exceptionally 18 - 20 m] high and 1 2 to 1 8 m in grith, the only tree equal it in size often being *Sterculia urens*- Teak, wherever it occurs in association, is generally stunted. It is leafless from February to May. Bamboo may occur

but is usually absent. There is low grass, scanty under-growth and the forests are usuaily burnt. *R*egeneration is usually absent.

DISTRIBUTION - On dry plateaux and hills throughout peninsular India. There is a distinict. more are less pure, continuous beit about 1 - 3 km. wide, on the higher reaches of Satpuras in Khargone division Madhya Pradesh

LOCALITY FACTORS - *R*ainfall 500 to 1,300 mm with a long hot dry season. The type occurs on a variety of rocks, particlarly crystalline, sometimes lateritic rockstarp and shales, The soil is usually bouldery or pebbly shallow and dry. Hill tops, ridges and spurs, and well drained plateanx are the usual sites.

FLORISTICS

(i) Khargone Divison, Madhya Pradesh.

Boswellia serrata Tectona grandis Lannea coro-mandelica, Hardwickia binata Terminalia tomen-tosa, Hymenodictyon excelsum, Sterculia urens.*

II. Sparce. *Acacia catechu, Anogeissus latifolia, Bauhinia malabarica.*

II(a). *Deodrocalamus strictus* (lo).

III, Sparce - *Nyctanthes arbort- tristis.*

(ii) Nimar. Madhya Pradesh.

I. *Boswellia serrata**, *Acacia catechn*. *Cochlospermum religiosum*, *Lannea coromandelica* *Commiphora muhul* (o),

IIa. *Dendrocalamus strictus* (l).

(iii) Seoni Division Madhya Pradesh

I. *Boswellia serrata** *Cochlospermum religiosum*, *Sterculia urens* *Lagerstroemia parviflora*, *Embilca offlcinalis*

III. Practically no shrubs.

IVb. Grass very light.

(iv) Baretha Betul Division Madhya Pradesh.

I. *Boswellia scrrata* (a), *Buchanania lanzan* (o), *Lagerstroemia parviflora* (o), *Soymida febrifuga* (r), *Terminalia tomentosa* (f).

II. *Nyctanthes arbor - tristis* (la), *Diospyros melan oxylon* (f), *Emblica officinalis* (f), *Ougenia oojeinensis* (f), *Acacia catechu* (o), *Bauhinia racemosa* (o).

IV. Verylittle grass or herbs.

GENERAL NOTE :

A very stable from on special sites, extended by maltreatment as *Boswellia* is usually left standing when other trees are felled and as it is very fire resistant. It does not coppice well it often only forms a narrow strip on ridges in the dry teak forests to which it would often probably prograss or revert with long continued fire protection

E3—BABUL (*ACACIA ARABICA*) FOREST

Description - The general appearance of the forest is entirely dominated by the one species *Acacia arabica* which is markedly gregarious in habit and forms a denser cover than usual in thorn forest. Biottc factors have also undoubtedly been in play. The few associated species occur mainly where the *Acacia* canopy is broken, and there is usually very little undergrowth. There is a rather thin cover of grass. Grazing is usually very heavy.

Distribution - Best developed in Berar but met with eleswhere under similar conditions e. g in Poona division, Maharashtra.

Locality Factors - This type is associated with black cotton soil. The climate data given for Akola are representative, those for Amraoti and Buldhana being very similar.

FLORISTICS

(i) Berar, Maharashtra (VAHID)

I/II. *Acacia. arabica**, *A. eburnea*, *Balanites aegyptiaca*, *Dichrostachys cinerea*. *Acacia leucophloea* *Prosopis spicigera*, *Zizyphus vulgaris* *Phoenix sylvestris* (wet ground) *Azadirachta indica*.

III. *Cassia auriculata*, *Capparis grandis*

IVa *Cassia tora*.

IVb. *Heteropogon contortus* *Ischaemum pilosum*, *Chrysopogen fulvus*, *Dichanthium annulatum* etc.

NOTE: The Bearer forests have undoubtedly been fundamentally altered by human influences, but the type is a well defined one.

E4 — *HARDWICKIA FOREST*

DESCRIPTION - The forest has the general appearance of the group but the predominance of *Hardwickia binata* which is nearly evergreen and of different habit from its associates gives is a character of its own. Most forests have been much maltreated, grazed and burnt. Pure consociations are often found within the dry deciduous type, akin to but much more restricted than consociations of dry teak.

DISTRIBUTION : Scattered in blocks and patches in the drier parts of the Peninsula from the Satpuras (Khargone.

Kannod Division, Madhya Pradesh) through Maharashtra (Khandesh, Nasik) southwards through the plateau region of Andhra Pradesh and Mysore down to Salem in Madras.

LOCALITY FACTORS - Rainfall 500 to 1,000 mm. The distribution of the type has not yet been satisfactorily correlated with climatic and soil conditions although edaphic influences seem to predominate. It is most characteristic of shallow hard gravelly soil over trap but occurs on variety of other rocks though then more mixed with other trees.

FLORISTICS

(i) Barwani, Khargone Division, Madhya Pradesh,

I/II. *Hardwickia binata** *(70%), Boswellia serrata. Lannea coromandelica, Anogeissus latifolia- Albizzia lebbek, Lagersteormia parviflora, Dios. pyros tomentosa, Tectona grandis, Acacia catechu.*

IIa. *Dendrocalamus strictus,* (o),

NOTE : Similar floristics are found in Khandesh, Maharashtra with a *Cassia auriculata* undergrowth. The *Hardwickia* trees in better areas attain 1.5 m. girth and 25 to 30 m. height but a dense pole crop is usual. On the poorer areas the crops is purer but rarely exceeds 15 m. in height.

(ii) S.Cuddapah, Andhra Pradesh (P.P. 3).

I *Hardwickia binata**

II *Acacia chundra*

III *Zizyphus* sp., *Mimosa* sp.

(ii) Tirupati Hills, Andhra Pradesh.

I/II *Hardwickia binata pterocarpus santalinus, P. marsupium, Chloroxyion swietenia, Terminalia chebula, T. tomentosa, Albizzia lebbek, Dalbergia latifolia etc.*

E5 — *BUTEA* FORESTS

DESCRIPTION - On ground this type presents a savannah appearence with scattered stunted and very malformed trees thickest standing over short grass or bare ground, on lower hill slops almost pure consociations are found, on screes and gravel derived from basic rocks and yielding clayey soils. Sometimes found as a conpicuous association in degraded forests eg. *Butea - cassia.*

DISTRIBUTION - Locally wherever soil conditions are suitable throughout the dry deciduous and the moister and of the thorn forests.

LOCALITY FACTORS - Stiff badly rained clay soils or very dry clayey soils, and particularly black cotton soils, in ill drained falts and depressions and at the foot of hills are characteristic of this type.

GENERAL NOTE :

Butea is often found in small patches in valley types of forests throughout the entire region particularly in teak and *Anogeissus pendula* type where it is usually associated with *Terminalia and Syzygium*.

This is a pronounced edaphic subtype though sometimes a closely similar from develops with maltreatment in dry deciduous and *Acacia* scrub forests.

E6 — *AEGLE* FOREST

Description - An open dry deciduous forest in which *Aegle marmelos* predominates often forming nearly pure consociations It is only leafless for a short peroid.

Distribution - In the dry deciduous and the drier part of the moist deciduous tracts.

Locality Factors - Typically on stiff dry clayey alluvial soils, which sometimes often contain manganese nodules. The sites are frequently elavated, usually well drained and water logging does not occur.

GENERAL NOTE :

The type occurs as islands in dry sal or inferior moist sal forest in which it is said to be encroaching and indicates signs of progressive desiccation *Aegle* has great power of reprouduction by root suckers. These forests form a well defined edaphic climax.

E7 — LATERITIC SCRUB

NOMENCLATURE - Kerala Mesophytic scrub (DAVIS)

DESCRIPTION - Irregular scrub of stunted trees of deciduous habit, sometimes with thorny species dominating, with thin undergrowth including xerophytic evergreens.

DISTRIBUTION : On the west coastal plains from Kanara downwards to Kerala.

LOCALITY FACTORS - The climate is that of the semi evergreen of even evergreen forest, but the type is determined by the dry shallow soil which is usually hard laterite, probably exposed, denuded and hardened by human influences.

FLORISTICS

(i) N Kanara, Mysore (ARORA)

I. *Terminalia chebula, Careya arborea, Santalum album (o)*

II/III. *Gardernia*, Pavetta, Ixora coccinea, Glochidion, Flacourtia indica, F. montana, Osyris wightiana, Randia dumetorum*, Canthium dicoccum.*

V. *Dalbergia sympathetica Jasminum malabarieum, Celastrus paniculata, Zizyphus* spp.

(ii) N. Mangalore Division, Mysore.

I. *Acacia chundra*, Litsea wightiana*, Buchanania lanzan, Lannea coromandelica, Anacardium occidentale* (*planted or natural*)

NOTES : There is an obvious rememblance to the Southern thorn forest.

(iii) Kerala (CHANDRASEKHARAN)

I/II. Stunted trees of *Terminalia tomentosa, T. Paniculata, careya arborea, Emblica officinalis Strychons nux-vomica. Buchannaia lanzan, Lannea corromndelica Bridelia retusa. Tectona grandis* (o), *Butea monosperma.*

III *Calycopteris floribunda, Carissa spp, Dodonaea viscosa, Combretum* sp., *Zizyphus* sp, *Holarrhena antidysenterica, Randia* sp., *Pavetta*, *Calotropis* sp.

IVa. *Cassia tora, Sida rhombifolia,*

E8 — SALINE/ALKALINE SCRUB SAVANNAH

Description - Irregular semi-savannahgrowth, occasionally dominated by single trees species, patches, of low tree and scrub growth alternating with grassy areas or bare soil covered with white efflorescene (where salt concentration is very high).

DISCRIPTION - Throughout the Indo-Gangetic plains and locally in valleys in the peninsular region.

LOCALITY FACTORS - The climate is that associated with the dry deciduous forest. The soil is alluvial, usually clayey, occasionally with a concretionary lime pan not much below the surface, with saline/alkali salts concentrated in the upper layers. External and internal drainage are both usually restricted.

SUB DIVISION - Differences in locality factors chiefly topographic and edaphic necessitate recognition of the following subtypes:

a, *PHOENIX SAVANNAH*

b. BABUL SAVANNAH

c. *SALVADORA - TAMARIX* SCRUB

E8/a—*PHOENIX* SAVANNAH

Phoenix sylvestris occurs as pure gregarious riparian fringing vegetation on narrow alluvial deposits along streams, or over much more extensive lowlying areas adjacent to large rivers the common, attribute often being the clayey (and locally *usar*) nature, of the top soil and periodic inundation leading to temporary or more frequently, prolonged water logging. It is thus found

along many smaller steams in Punjab. Uttar Pradesh (even along water logged canals) — Madhya Pradesh etc. It is occasionally associated with *Butea monosperma, Carissa opaca. Capparis, Salvadora* etc. *Imperata cylindrica Desmostachya bipinnata* and *Vetiveria Zizanisides* are the common of grasses.

In Southern India *Borassus flabellifer*, often occupies an identical niche in the general habitat either by itself or mixed with *Phoenix sylvestris*.

E8/6 — BABUL SAVANNAH

In the old alluvium region of Punjab and Uttar Pradesh and elsewhere in Northern India extensive patches of Usar land occur, characterised by high saline/alkaline condit ions (with or without saline pan). Similar conditions are developed in the black cotton soil region in the peninsula. The characteristic vegetation is an open savannah with scattered trees and a few bushes over low grass. The ground is bare where the concentration of salt is excessive.

E8/c — *SALVADORA - TAMARIX SCRUB*

In Saurashtra the saline/alkaline soils support a *Saluadora- Tamarix* community *Salvadora oleoides*, occasionally *S. persica*, and locally *Tamarix aphylla* from characteristic associations. The usual under-growth is *Calotropis procera C. gigantea, Capparis decidua, Indigofera* sp. and locally *Suaeda fruticosa* and *Salsola foetida*.

E9 — DRY BAMBOO BRAKES

DESCRIPTION - Only one species *Dendrocalamus strictus*, occurs forms relatively low (rarely over 7 m.) but often dense brakes. Where grazed, the bamboo grows in dense patches with grass and deciduous often thorny shrub between. A scattered overwood of the hardier species of the dry deciduous forest may indicate the dominance of the bamboo to be only secondary. Sometimes there is practically no overwood.

DISTRIBUTION - Throughout the dry deciduous type with marked local preponderance, Good examples occur in punjab (Hoshiarpur). Uttar Pradesh (Lansdowns), Bihar (Palamau etc.), Rajasthan (Banswara) Gujarat (Vijara) in most divisions of Madhya Pradesh, Maharashtra and Mysore, in Madras (Salem) etc.

LOCALITY FACTORS - Occurs mainly on dry hillsides but also on alluvium with rainfall of 900 mm or rather more. The soil is dry most of the year and often shallow and stoney as well.

FLORISTICS

(i) General

*Dendrocalamus strictus** with a sprinkling of the tree and shrub species of the local form of dry deciduous forest, thus in C. and S. India teak. *Boswellia serrata*, *Sterculia urens* and *Cochlospermum religiosum*, in N India *Anogeissus latifolia* aud *Lannea coromandelica*,

NOTE : Biotic factors certainly influence the occurrence of this bamboo brake and the absence of trees may often be due to them, but apparently natural example also occur appearing to be associated with soil conditions.

For a comprehensive account see DEOGUN (1937)

SERAL TYPES OF DRY DECIDUOUS FORESTS

PRIMARY SERAL TYPES.

ISI - Dry tropical riverain forest.

IS3 - Inundation *babul* forest.

SECONDARY SERAL TYPES.

2SI - Secondary dry deciduous forests.

PRIMARY SERAL TYPES

Type ISI

DRY TROPICAL RIVERAIN FOREST

DESCRIPTION - An irregular overwood of greater height than the climax dry deciduous forest, the trees often being of larger size and forming patches and strips with verying amounts of smaller trees (and shrubby undergrowth. The foliage is more or less evergreen in several of the chief dominants. The soil is often bare sand, which may first be colonised by shrubs or grass .

Distribution - Narrow strips along the hilly sections of the larger streams in the dry deciduous forests widening as the valleys got broader and extending into the moist deciduous types also.

Locality Factors - A light sandy soil often overlying more or less impervious rock (Deccan trap being typical) liable to be temporarily submerged dvring the short monsoon period, and usually retaining adequate water supplies most of the year, Air temperatures must be relatively high owing to radiation from the exposed rock and sand

Floristics

(ii) Wainganga/Wardha River junction. S. Chandra Division, Maharashtra.

I. *Terminalia arjuna** (a), *Anogeissus acuminata* (f), *Mitragyna parvifolia* (o).

II. *pongamia pinnata* (a), *Barringtonia acutangula*, *Alangium salvifolium* (a), *Bauhinia malabarica* (f), *Streblus asper* (f), *Diospyros tomentosa* (o). *Butea monosperma* (o) *Strychnos nux-vomica* (o) *Tamarindus indica* (o) *Mallotus philippensis* (f),

III. *Helicteres isora* (o).

IVb. Very little grass.

V. *Derris scandens* (o), climbers very few,

NOTE : The scrub consocies of *Homonoia* spp , *Tamarix dioica Ficus* spp , *Eugenia heyneana*, *Vitex*. *Acacia jacquemontii*, etc. , which grow in the actual river bed and are adopted to complete submersion, are met with in adjoining sites. These shrubs are characterised by long flexible branches which give to the moving water and usually by elongate simple leaves. The tree species occur on stablished or rocky banks or in islands where pockets of firm soil exist,

IS3 — INUNDATION BABUL FOREST

Description - A fairly complete canopy 10 to 15 m, high formed by practically pure crops of *Acacia arabica*. As the level is raised and the soil gets drier, the species of the climax type represented by *Prosopis spicigera*, *Acacia leucophloea* and occasionally *Acacia catechu* (persisting and stablished from the seral stage) appear. There may be scattered shrubs of *Zizyphus* spp., *Carissa opaca* etc., and dense short grass.

Distribution - Along the larger streams in Maharashtra and C. India locally in N. India.

Locality Factors - The river generally begins to rise at the begining of May and the rise continues with some interruptions till about the middle or end of July and sometimes later. There after it generally subsides and reaches its winter level about the end of October. Actual

flooding 6 weeks is necessary for good development. There is however; a great deal of variation from year to year and erosion and deposition is constantly in progress. Fires are likely to occur in the heavy grass from December to May. Grazing is usually very heavy.

FLORISTICS

(ii) Dhond, Poona Division, Maharashtra.

I. *Acacia arabica**, *Azadirachta india* (naturalised) *Ailanthus excelsa*

II *Pongamia pinnata*, *Zizyphus mauratiana.*

GENERAL NOTE :

This form grows under different soil conditions from the black soil subtype.

SECONDARY SERAL TYPES

2SI — SECONDARY DRY DECIDUOUS FOREST

DESCRIPTION - An inferior form of the climax type marked by the poor shape and size of the trees, absence of old trees except some times scattered semi-cultivated or useless species, and irregular stocking. Thorny species and species unpalatable to cattle tend to predominate. Sandal is an important and often characteristic feature.

DISTRIBUTION - Throughout the dry deciduous forests extending into the drier parts of the moist deciduous.

LOCALITY FACTORS - As for the general group (cf.p 198) but the forest has been subjected to more or less complete clearance at some time in the past for shifting or semi-permanent cultivation and has grown up again, usually subject to heavy use for grazing, fuel and small timber. The surface soil is commonly hard and impervious from exposure and trampling

FLORISTICS

(ii) Dharwar Taluka Forests, Mysore.

I. *Salmalia malabarica, Buchanania lanzan, Grewia tiliaefolia, Elaeodendron glaucum. Schleichera oleosa, Lannea cormandelica, Semecarpus anacardium. Tectona grandis*

II. *Feronia limonia. Aegle marmelos, Zizyphus xyloporus, Careyaarborea, Gardenia* spp., *Dolichandrone atrovirens, Santalum album**.

III. *Dodonaea viscosa**, *Carissa spinarum, Holarrena antidysentericag Lantana* (a).

NOTE : An open parklike forest in which the trees grow in groups separated by grassy glades often well high impenetrable by *Lantana* brakes.

GENERAL NOTE :

These examples are typical and it is unnecessary to give others. *Soymida* has been quoted (VAHID) as a species colonising abandoned cultivation.

GROUP 6 - TROPICAL THORN FORESTS

Subgroup 6A - Southern Tropical Thorn Forests

1. NOMENCLATURE

Madhya Pradesh Thorn Forests

Babul bans

Maharashtra

Thorn Forests
Thorn and scrub forests
Riverain babul

Madras & Mysore

Scrub jungle
Semi desert scrub
Acacia sundra forest

2. GENERAL DESCRIPTION

An open low forest in which thorny usually hard. wooded species predominate, *Acacia* sp., being particularly characteristic. The trees usually have short boles and low branching crowns which rarely meet. The usual height is 6 to 9 m. There is usually a mixture of species (though relatively few in number), consociations being the exception rather than the rule. There is an ill-defined lower storey

of smallar tress and large shrubs, mostly spiny and often with other xeaophytic characters, exrending down to low shrub growth of similar character. There is usually a thin grass growth which may appear fairly complete during the short moist season, but more or less of the soil is bare Climbers are few, also frequently showing xerophytic adaptations.

3. DISTRIBUTION

In C. India throughout the dry peninsular tract to the lee of the W. Ghats from the extrem south up to Indore and Bhopal. It is thus important in Maharashtra, Andhra Pradesh, Mysore and Madras.

4. LOCALITY FACTORS

TEMPERATURE - Data for a selection of representative stations is given on the next pages.

The mean annual temperature is not appreciably higher than for the other tropical types, being typically 25.5°C. A few places such as Bellary are hotter and Bangalore with its extra 300 m. of altitude a few degrees cooler. The hottest month ls May when the monthly mean is usually 29.5 to 32°C whilst the mean maximum is usually over 41°C with mean minimum varying from as low as 4.4°C. (Akola) upto 13.3°C (Coimbatore) some 10° latitude further south.

TEMPERATURE (CENTIGRADE)

SOUTHERN THORN FORESTS

Month	Maharashtra AKOLA 282 m. mean	Mean max.	Mean min.	Maharashtra POONA 557 m. mean	Mean max	Mean min.
Jan.	21·4	30·1	12·7	21·0	30·3	11.7
Feb.	23·4	32·6	14·3	22·7	32·5	12·8
March	28·0	37·1	18·9	26·3	36·1	16·5
April	32·3	40·8	23·8	29 2	38·3	20·2
May	34·9	42·3	27·4	29·8	37·1	22·4
June	31·5	37·2	25·7	27·5	31·9	23·1
July	27·8	31·7	23·8	25 1	28·1	22·1
Aug.	27·0	30·8	23·7	24·5	27·6	21·4
Sept.	27·4	31·9	22·8	24·9	29·2	25·0
Oct.	26·6	33·7	19·4	25·5	31·9	19·1
Nov.	22 9	31·1	14·7	22 6	30·3	14·7
Dec.	20·6	29·3	11·6	30 6	29·4	12·2

	AKOLA	POONA
M. A. T.	—	—
Annual mean max	34·1	31·9
Highest record	47·2	43·3
Annual mean min.	19 9	18·0
Lowest record	2·2	1·7
No. of years	60 (to 1940)	60 (to 1940)

TEMPERATURE (CENTIGRADE)

SOUTHERN THORN FORESTS

Month	Maharashtra SHOLAPUR			Andhra Pradesh BIJAPUR		
	479 m. mean	Mean max.	Mean min.	594 m. mean	Mean max.	Mean min.
Jan.	23·0	30·8	15 2	22·9	30·1	15·7
Feb.	25·3	33·6	17·1	25·3	32·8	17·7
March	29·0	37·3	20·7	28 7	36·1	21·2
April	31·9	39·7	24·1	30·9	38·2	23·6
May	32·7	40·4	25·0	31·2	38·7	23·6
June	28·7	35·1	22·0	27·8	33 4	22·3
July	27·1	31·8	22·3	26·0	30·3	21·6
Aug.	26 7	31·6	21·7	25·8	30·4	31·1
Sept.	26 6	31·5	21·7	25·9	30·8	21·1
Oet.	26·5	32·6	30·4	26·0	31·5	30·4
Nov.	14·0	30·8	17·1	23·4	29·8	17.1
Dec.	22·2	29 7	14·7	21·9	29·0	14·8
M. A. T.	27·0			26·3		
Annual mean max.	33·7			32·6		
Highest record	45·6			42·8		
Annual mean min.	20·3			20·0		
Lowest record	6.1			6·7		
No. of years	60			45		

TEMPERATURE (CENTIGRADE)
SOUTHERN THORN FORESTS

Month	Andhra Pradesh KURNOOL			Mysore BELLARY		
	281 m. mean	Mean max.	Mean min.	449 m. mean	Mean max.	Mean min.
Jan.	23·9	31·3	16 4	23·9	31·0	16·8
Feb.	26·6	34·2	18·9	26·2	33·4	18·9
March	23·4	37·8	23·1	29 9	37·5	22·4
April	23·9	39·8	26·1	30·4	35·5	25·2
May	33·8	40·3	27·2	32·2	38·9	25·4
June	30·7	31·2	25·3	29·6	34·8	24·4
July	28·6	33·1	23·9	28·2	32·6	23·9
Aug.	28 0	32·5	23 5	27·2	32·5	23·3
Sept.	27·8	32·2	23·3	27·7	32·5	22·5
Oct.	27·3	32·6	22·1	27·0	32·1	21·8
Nov.	24·9	31·1	18·8	24·8	30·6	19.0
Dec.	23·2	30 2	16·0	23·2	29·8	16·6

	Kurnool	Bellary
M. A. T.	28·2	—
Annual mean min.	34·3	33·3
Highest record	45·6	43·9
Annual mean min.	22·0	22·1
Lowest record	6‘7	10·6
No. of years	50	60 (to 1940)

TEMPERATURE (CENTIGRADE)

SOUTHERN THORN FORESTS

Month	Mysore MYSORE			Madras COIMBATORE		
	667 m. mean	Mean max.	Mean min.	409 m. mean	Mean max.	Mean min.
Jan.	22·5	29·0	16·0	24·2	30·0	18·3
Feb.	24·8	31·6	17·9	25·9	32·7	19·2
March	27·1	34·3	19·8	28·2	35·2	21·2
April	28·1	34·8	21·3	28·2	33·2	23·1
May	27·2	33·3	21·1	28·9	34·7	23·1
June	24·7	27·9	20·1	26·9	31·6	22·2
July	23·7	20·4	19·6	26·1	30·4	21·7
Aug.	23·8	28·3	19·3	26·2	30·8	21·7
Sept.	24·1	29·0	19·2	26·6	31·5	21·6
Oct.	24·2	29·0	19·4	26·2	30·9	21·5
Nov.	23·0	27·9	18·0	25·1	29·7	20·6
Dec.	21·9	27·7	16·2	24·0	29·1	18·9
M. A. T.	24·6			—		
Annual mean max.	30·2			31·8		
Highest record	38·3			40·0		
Annual mean min.	12·0			21·1		
Lowest record	10·6			11·7		
No. of years	45			60 (to 1940)		

TEMPERATURE (CENTIGRADE)

SOUTHERN THORN FORESTS

Month	Madras TUTICORIN			Madras PAMBAN		
	4m. mean	Mean max.	Mean min.	11 m. mean	Mean max.	Mean min.
Jan.	25·1	27·7	22 3	25·9	28·1	23·6
Feb.	25·7	28·2	23·1	26·6	29·3	23 9
March	27·1	29·6	24·7	28 2	31·4	24·6
April	31·4	37·1	25·7	29·7	32·8	26·5
May	30·5	34·5	26·4	30·2	33·2	27·3
June	30·0	35·4	26 6	29·6	32·3	26·8
July	30·3	34·1	26·6	29·1	31·8	36·3
Aug.	30·3	34·2	26·4	28·9	31·7	26·0
Sept.	29 3	29·9	25 8	28·9	31·8	25·9
Oct.	29·1	32·8	25·3	28·2	31·1	25·4
Nov.	26·7	29·7	23·6	27·1	29·5	24.6
Dec.	24·4	27 4	21·5	25·9	28·1	23·8

	Tuticorin	Pamban
M. A. T.	28·4	28·2
Annual mean min.	31·9	30·9
Highest record	—	37·2
Annual mean min.	24·8	25·4
Lowest record	—	19·4
No. of years	(upto 1955)	50

RAINFALL AND HUMIDITY - The rainfall data for the same localities with one additional station are given in the attached statement :—

Mysore exemplifies conditions varging on those characteristic of the dry deciduous. Althogh Akola receives a longer rainfall, the humidity is lower. The much greater humidity of the southernmost stations will be noted, northern stations being well below 60. There is typically practically no rain from November to April inclusive and very little in May, atleat two-thirds and usually a larger proportion of the precipitation occurring as monsoon rain in June to October. Coimbatore has a different distribution with October and November as the only months with a fall over 100 mm. very little rain being derived from the S. W. Monsoon.

RAIN FALL (MILLIMETRES)

SOUTHERN THORN FORESTS

Month	Maharashtra AKOLA 282 m.	Maharashtra POONA 559 m	Maharashtra SHOLAPUR 479 m.	Maharashtra DHOND	Andhra Pradesh BIJAPUR 594 m.	Andhra Pradesh KURNOOL 281 m.
Jan.	9	2	4	3	5	4
Feb.	8	2	3	2	2	7
March	9	2	6	10	5	5
April	5	15	14	21	22	17
May	10	27	23	87	29	27
June	141	114	103	63	77	74
July	249	167	106	43	60	112
Aug.	161	90	109	33	61	114
Sept.	147	134	193	61	141	151
Oct.	46	90	77	30	73	81
Nov.	19	27	34	6	32	30
Dec.	14	4	10	4	6	5
Total for year (M.A.R.)	817	673	691	261	513	630
No. of rainy days	45	47	41	31	33	45
No. of months less than 50 mm.	8	7	7	8	7	7
M. A. Humidity	49%	58%	47%	—	52%	52%
No. of years	—	—	60	49	45	50

RAIN FALL (MILLIMETRES)

SOUTHERN THORN FORESTS

Month	Mysore BELLARY 449 m.	Mysore MYSORE 667 m.	Madras COIMBATORE 409 m.	Madras TUTICORIN 4 m.	Madras RAMNAD	Madras PAMBAN 11 m.	Madras TINELVELY
Jan.	3	4	16	26	39	65	54
Feb.	5	6	9	25	23	22	27
March	5	13	13	29	23	18	42
April	21	58	40	43	48	47	62
May	48	142	63	21	30	25	37
June	43	63	39	5	10	4	9
July	41	68	42	4	20	12	10
Aug.	61	84	31	6	41	15	20
Sept.	124	126	40	16	51	29	36
Oct.	106	149	160	141	199	217	186
Nov.	50	70	162	183	242	298	196
Dec.	3	10	35	85	125	193	130
Total for year M. A. R.	518	792	590	583	850	943	810
No. of rainy days	34	57	45	29	41	48	45
No. of months less than 50 mm.	8	4	9	9	8	8	7
M. A. Humidity	50%	63%	67%	69%	—	81%	—
No. of years	—	45	—	—	71	50	30

SOIL - The type is met with on a wide range of geological formations and rocks. The soil is almost always shallow and dry, though it may be of fair depth if sands. The type also predominates on the black cotton soil of Berar and elsewhere, and with much higher rainfall on hard laterite soil. In many localities the soil is very alkaline. Most of the forest is on flat ground or low undulating hills and plateaux.

5. GENERAL FLORISTICS

The genus *Acacia* with a number of species and several other allied genera, is characteristic above all others. Flesy *Euphorbias* are generally present and may form at conspicuous constituent ot the vegetation; and *Capparis* is also a typical genus, *Opuntia* has become a naturalised over wide tracts of this type, but is not indigerous.

6. SUBDIVISIONS

The thorn forest of the Carnatic in the Southern-Eest differs significantly in composition etc., from the rest A general scrub form and another in which *Euphorbia* predominates are also differentiated as degradation stages. Edaphic inflluences aie probably involved in the formation of the *Euphorbia* type.

C1 - Southern thorn forest
C2 - Carnatic umbrella thorn forest.
DS1 - Southern thorn scrub.
DS2 Southern *Euphorbia* scrub.

C1 ... SOUTHERN THORN FOREST

DESCRIPTION - This is the central form of the type as described on p. *Acacia catechu* is one of its forms *(A catechu SS. A. catechuoides A. chundra)* is almost invariably present and though not necessarily predominating, is very often so. With it are associated several other *Acacias* and allied thorny *Mimosae* and usually *Zizyphus*, whilst stunted specimens of the trees of the dry deciduous forest occur scattered in varying number throughout, notably *Anogeissus latifolia*, *Soymida* and the like. Patches of the fleshy *Euphorbia* are not infrequently met with.

DISTRIBUTION - The most widely spread from occuring throughout the tract occupied by thorn forests except on the south coastal tracts where it is replaced by C2.

LOCALITY FACTORS - Those of subgroup. see P.

FLORISTICS

(i) Lontek, Amraoti Division. Maharashtra.

I. *Acacia leucophloea** (a). *A, arabica** (f), *Balanites aegyptiaca* (f), *Cordia dichotoma* (6m. high).

II. *Dichrostachys cinerea** (a), *Phoeniz* (o), *Gymnos. poria* spp.. (o), *Zizyphus maratiana* (f).

III. *Mimosa hamata** (a), *Calotropis procera* (o),

IVb *Heteropogon contortus* and other grassess forming a thin cover.

IV. *pergularia daemia (a), Cardiospermum* (f) etc.

NOTE : Total cover about 05 with bare *Kankar* patches heavily *grazed*.

(ii) Dhond, Poona Division, Maharashtra.

I. *Acacia arabica*. A latronum*, Capparis decidua, C. divaricata, Balanites aegypticaca, Prosopis spicigera, Azadirachta indica,* (*Zizyphus mauratiana. Dichrostachys*).

II. *Mimosa hamata*, Cassia auriculata.*

IVb. *Aristida reducta, A. roylhana, Heteropogon contortus.**

(iii) Sholapur Division Maharashtra.

I & II. *Acacia cateehu*, A. leucophloea*, Anogeissus latifolia, Azardirachta india. Bauhinia racemosa, Flacourtia indica Randia, Zizyphus mauratiana, Z. vulgaris, Gardenia gummifera, Dolichandrone falcata, Santalum album, Strychnos potatorum, Grewia tilliaefolia, arborea*

III. *Mimosa hamata, Bridelia stipularis, Cassia auriculata.*

(iv) Ellora, Mndhra Pradesh

Acacia catechu, A. leucophloea*, Ailunthu. excelsa, Azadirachta indica, Dolichandrone falcatas*

Gymnosporia spinosa, Ixora arborea, Carissa carandas, C. spinarum, Euphorbia.

(v) Panapakam, Chittoor Division, Andhra Pradesh.

I. *Albizzia amara*, Acacia chundra*, Azadirachta indica, Cassia fistula, Albizza odoratissima, Randia dumetorum, Anogeissuslatifolia.*

III. *Carissa carandas Canthium dicoccum. Strychnos* sp, *Dodonaea viscos.ı,Cassia auriculata,*

IVb. *Aristida*, Heterpogon contortus.*

V. *Zizyphus oenoplia,*

(vi) Dharwar - Bijapur Division, Mysore.

I. *Acacia catechu*, A, leucophloea*, A. arabica*, Aegle marmelos, Chloroxylon swietenia Euphorbia nivuiia, Ficus asperrima, Flacourtia indica. Ixora arborea, Strychnos potatorum, Santalum album.*

II *Carissa* spp., *Caessia auriculata, Dodonaca viscosa, Opuntia (* nat)

III. *Lantana* (nat)

V. *Zizyphus oenoplia.*

(vii) *C.* salam Madras.

I/II *Chloroxylon swietenia*, Albizzia amara, Acacia chundra*, A. ferruginea*, Axadirachta indica,*

Canthium dicoccum Erythroxylon monogynum, Zizyphus, mauratiana, Z. xylopyrus. Cleistanthus collinus, Dichroastachys cinerea, Atalantia monophylla.

Ecological Status - SCHIMPER was of opinion that thorn woodland is often the effect of excessive cutting and browsing and so often not a climatic formation. In Madhya Pradesh it is found that forest protection is permitting teak to displace the less exacting species such as *Sterculia urens* and *Diospyros tomentosa* (VAHID). The same applies to large parts of Rajasthan and Gujarat and no doubt eisewhere too.

C2 — CARNATIC UMBRELLA THORN FOREST

Description - As open thorn forest in which *Acacia planifrons* with its umbrella shaped crown is conspicuous with thickets of other species of *Acacia* and many of the xerophytic evergreen species of the dry evergreen forest. The resemblance to African thorn (savannah) forest is marked.

Distribution - Madurai, Tirunelveli, Ramnad, Rameshwarm, Dindigul etc. in S. Madras.

Locality Factors - The climate is represented in the table by Tuticorin. Ramnad and Pamban. It is marked by the low rainfall recieved from the S W. monsoon in June-September, the bulk of the rainfall coming in October-

November, Dry edaphic conditions as at Dindigul, or on costal sand dunes at Pamban, Rameswaram etc. also result in the development of this type.

FLORISTICS

I. *Acacia plainifrons*, Albizzia amara,*

II. *Acacia latronum*, Dichrostachys cinerea, Chloroxylon swietenia.*

III Thorny shrubs.

V. *Dalbergia spinosa*

TYPE 6A/C2/DSI & DS2

DSI — SOUTHERN THORN SCRUB

Degradation as a result of the usual maltreatment results in the formation of close almost impenetrable thorny thickets, 4 - 6 m. high, not much different in composition from the undergrowth characteristic of the prevailing climax type, in which the few surviving trees stand out here and there. Spiny climbers are common.

Further degradation may result in sparse thickets. 2 — 4 m. high, in which grasses are more abundant. The floristic composition remains essentially unaltered.

FLORISTICS

Plains region. Madras.

I. *Albizzia amara*, *Azadirachta indica* *Chloroxylon swietenia*, *Wrightia tinctoria* (very few and scattered),

III. *Zizyphus xylopyrus**, *Dichrostachys cinerea**, *Capparis divaricata*, *Securinega leucopyrus*, *Randia dumetorum*, *Canthium dicoccum*, *Flacourtia indica*.

V. *Pterolobium indicum*, *Acacia pennata*,

DS2 — SOUTHERN *EUPHORBIA* SCRUB

DESCRIPTION - A very open formation in which fleshy *Euphorbias* are the most important constituent. The thorny *Acacias* and their associates also occur but are more than usually stunted, and form widely spaced low rounded bashes. Much of the soil is bare but there is usually a thin cover of wiry grasses.

DISTRIBUTION - Scattered throughout the type usually on the shallowest and poorest sites.

LOCALITY FACTORS - Climate that of the type. Soil shallow and rocky or alkaline

FLORISTICS

(i) Krishnagiri, Madras.

I. *Euphorbia tirucalli**, *Capparis* sp*.

II. *Dodonaeaviscosa*, *Cassia auriculata*.

(ii) Dry Plains region, Madras,

I. *Euphorbia antiquorum*,* *E. tirucalli**.

II. *Dodonaea viscosa*, *Cassia auriculata*, *Calotropis gigantea*, *Barleria buxifolia*, *Opuntia dillenii*.

IV*b*, *Aristida hystrix*, *A. depressa*, *Cymbopogon coloratus* (o).

GENERAL NOTE :

This type is very widespread and represents both extreme edaphic conditions (badly eroded, very rocky, with soil in crevics only if the slopes are steep) as well as the ultimate stage in degradation. The scattered small consociations of *Euphorbia* sometimes found in dry deciduous forests should perhaps not be included here.

GROUP 7 - TROPICAL DRY EVERGREEN FORESTS

CI - Tropical Dry Evergreen Forests

NOMENCLATURE

Andhra Pradesh

Dry evergreen forest (TROUP, ETC.)

Carnatic Evergreen

GENERAL DESCRIPTION

A low forest, 9 to 12 m, high, but forming a complete canopy consisting mostly of small coriaceous leaved evergreen trees with short boles and spreading crowns. The proportion of deciduous species may be large locally. There is no marked differentiation of canopy layers between the shrubby underwood which includes many spiny species and the top canopy. A few species from the bulk of the crop which, is however, decidedly a mixed type, pure consociations being exceptional. Climbers are numerous. Bamboos, are rare or absent. Grass is present but not conspicuous. Most of the forests have been much influenced by felling, lopping and browsing and have become irregular with open patches, and the thorny and unpalatable species have largely displaced the climax vegetation.

DISTRIBUTION

This type is restricted to the Karnatak coast where unusual climatic conditions prevail. It is found on the east coast from Tirunelveli northwords to Nellore. Similar forest referfed to as "Dry zone forest" occurs over large areas in Ceylon and is there better developed than in India though much of it is known to be of secondary origin after clearing at very varying periods.

LOCALITY FACTORS

TEMPERATURE - The following table gives the seasonal data for stations in the tract in which the type occurs. Of these Masulipatnam and Madras are right on the coast. and so enjoy a more equable and dapmer climate than usual, whilst Tiruchirapalli and Madhura are for inland at the opposite extreme, but it will be noted that the difference are small.

Mean annual temperature is 27° to 28° C the hottest month being May or June with a mean temperature of 30° -31° C. The coldest months are December and January with a mean temperature of 23° -24.5° C. The mean maxima and minima of the year are about 42° C and 15°C.

RAINFALL AND HUMIDITY - For the same sections the data are given in the attached table. The rainfall is very largely from the retrealing or N.E Monsoon with maximum falls in October and November. The inland stations show

a subsidiary maximum in May ascribable to the S. W. monsoon with a definite break between the two rainy seasons, whereas the coastal stations show a slow but continuous increase from May onwards. The dry period is longest at Masulipatam with 6 months (December to May) with less than 50 mm. monthly, but is only 3 months at Madura. (January - March), The mean humidity for the year is 82 at all these stations except Masulipatam where it is low as 74.

SOIL AND PHYSIOGRAPHY - The tract occupied varies a good deal with low hills and flats between. The soil is typically lateritic but the type is also developed to some extent on dune sands.

TEMPERATURE (CENTIGRADE)

SOUTHERN DRY EVERGREEN FORESTS

Month	A. Pradesh MASULIPATAM			Madras MADRAS		
	3 m. mean	Mean max.	Mean min.	20 m. mean	Mean max.	Mean min.
Jan.	23·6	28·3	18 9	24·6	29·6	19 5
Feb.	25·2	30·1	20·3	25·6	31·3	20 2
March	27·4	32·5	22·4	27·7	33·0	22·4
April	30·0	24·6	25·4	30·4	35·3	25·6
May	32·6	37·5	27·6	33·1	38·5	27·6
June	31·9	36·8	27·1	32·4	37 6	27·3
July	29·6	33·6	25·6	31·0	35·7	26·3
Aug.	29·2	32·5	25·5	30·4	34·9	25·8
Sept.	28·9	32·5	25·3	29·8	34·4	25·1
Oet.	27·9	31·4	24·4	28·1	32·3	23·9
Nov.	25·6	29·3	21·8	25·9	29·7	22.2
Dec.	23 7	28·1	19·2	24·7	28·9	20·5
M. A. T.	27 9			28·7		
Annual mean max.	32·3			33·4		
Highest record	47·8			45·0		
Annual mean min.	23·6			23·9		
Lowest record	13.9			13·9		
No. of years	60			60		

TEMPERATURE (CENTIGRADE)

SOUTHERN DRY EVERGREEN FORESTS

Month	Madras VELLORE			Madras TRICAINOPOLY		
	214 m. mean	Mean max.	Mean min.	78 m. mean	Mean max	Mean min.
Jan.	23.4	28.8	18.9	23.4	30.7	20.1
Feb.	25 3	31.6	19.0	27.1	33.4	20.7
March	27.8	34.6	21.0	29.6	36 2	22.8
April	30.8	37.1	24.6	31 8	38.1	25.6
May	32.4	28.8	26 1	32.4	38.6	26.2
June	31.1	36.2	25.9	31.6	37.1	26.1
July	29.8	34.5	25.1	30 9	36.1	25.7
Aug.	29.3	34.0	24.6	30.4	35.8	25.1
Sept.	28.8	33.4	24.1	27.1	35.2	24.6
Oct.	27.2	31.6	22.7	28.4	33.0	23.7
Nov.	24 8	29.1	20.6	26 5	30 6	22.4
Dec.	23.1	28 0	18 2	25.3	29.7	20.9
M. A. T.	27.8			29.1		
Annual mean max	33.2			34.6		
Highest record	44 4			43.9		
Annual mean min.	22 5			23.7		
Lowest record	12.2			13.9		
No. of years	40			60		

TEMPERATURE (CENTIGRADE)

SOUTHERN DRY EVERGREEN FORESTS

Month	Madras MADURA		
	133 m. mean	Mean max.	Mean min.
Jan.	25·1	29 9	20 2
Feb.	26 6	32·4	20·8
March	28 8	35·2	22·5
April	27 9	36·6	24 8
May	31·3	37·1	25·6
June	30·9	36·2	25 6
July	30·3	25·5	25·2
Aug.	29·9	35·1	24·7
Sept.	29·4	34·3	24·4
Oct.	28·0	32·3	23·7
Nov.	26·6	30·4	22·8
Dec.	25·3	29·3	21·2

M. A. T.	28·6
Annual mean max.	33·7
Highest record	42·2
Annual mean min.	23·4
Lowest record	15·6
No. of years	60

RAIN FALL (MILLIMETRES)
SOUTHERN DRY EVERGREEN FORESTS

Month	A. Pradesh MASULI-PATNAM 3 m.	Madras MADRAS 20 m.	Madras VELLORE 214 m.	Madras TRICHI-NOPOLY 78 m.	Madras MADURA 133 m.
Jan.	5	36	37	25	20
Feb.	14	10	6	12	14
March	11	7	7	9	18
April	18	16	25	46	55
May	34	26	48	84	70
June	107	47	70	41	40
July	162	91	116	34	50
Aug.	159	116	146	97	104
Sept.	162	119	175	120	119
Oct.	218	206	173	183	189
Nov.	147	355	195	148	146
Dec	17	138	67	71	51
Total for year M. A. R.	1052	1,268	1074	872	873
No. of rainy days	55	57	57	47	51
No. of months less than 50 mm.	6	6	4	6	5
M. A. Humidity	74	57	64	60	60
No. of years	60	60	40	60	60

FLORISTICS

The most conspicuous genus is *Manilkara*, (*Sapotaceae*); *Memecylon* (*Melastomaceae*) is also typical and common. *Diospyros* and *Eugenia* and sometimes *Chloroxylon* and *Albizzia amara* are present.

General.

I/II. *Manilkara hexandra**, *Mimusops elengi**, *Diospyros ebenum*, *Strychnos nux-vomica*, *Eugenia* spp., *Drypetes sepiaria* (r).

III. *Memecylon edule**.

NOTE: The type has been little studied.

(iii) Nagavera S. Cuddapah Division, Andhra Pradesh.

I. *Manilkara hexandra** (la), *Canthium dicoccum* (f), *Zizyphus glaberrima* (f), *Acacia leucophloea* (f), *Randia dumetorum* (lg), *Buchanania angustifolia* (o), *Strychnos nux-vomica* (o), *S. potatorum* (o), *Sapindus emarginatus* (o), *Diospyros chloroxylon* (o), etc.

II. *Carissa carandas* (a), *Flacourtia indica* (la), *Maba buxifolia* (f), *Grewia* sp. (a), *Gymnosporia* spp. (f), *Ixora arborea* (f), *Webera* sp. (f).

III. *Strobilanthes* sp. (a), *Dodonaea viscosa* (la).

IVb. Grass light.

V. Climbers abundant. *Derris scandens* (f), *Asparagus* spp. (f) *Acacia intsia* (a), *Pterolobium indicum*, *Zizyphus oenoplia* (a). *Combretum* sp. (f)

NOTE : The provides an example of transition to dry deciduous forest with *Anogeissus latifolia* etc. The prevalence of thorny species is probably largerly due to buman agencies.

(ii). Sriharikota Island, Nellore Division, A. P.

I. *Manilkara hexandra*, *Syzygium cumini*, *Albzzia amara*, *A, lebbek*. *Strychnos nux-vomica*, *Drypetes sepiaria* *Ficus tsilia*, *Sapindus emarginatus*, *Tamarindus indica*, *Azadirachta indica*, *Pterospermum snberifolium*, *Borassus rabellifer*.

II. *Memecylon umbellatum**, *Maba buxifolia**, *Garcinia spicata*, *Crataeva religiosa*, *Atalantia monophylla*, *Cordia dichotoma*, *Cmelina arborea* *Peoenix sylvestris*, *Flacourtia indica*.

III. *Glycosmis pentaphylla*, *Ochna squarrosa*, *Randio* spp.

IV. Sarasaparilla some grass.

V. *Calamus viminalis*.

DSI — TROPICAL DRY EVERGREEN SCRUB

Much of the climax forest has been degraded resulting in the disappea ance of the trees; the remnants are thorny shrubs, There is thin grass,

FLORISTCIS

(i) Vandalur, Saidapet Division, Madras.
*Memecylon edule**, *Zizyphus glaberrima*, *Dichrostachys cinerea Randia dumetorum*. *Carissa spinarum.*

(ii) Navalur, Madurantakam, Madras.

*Memecylon edule**, *Albizzia amara*, *Buchanania lanzan*, *Maba buxifolia*, *Randia dumetorum*, *Carrissa spinarum*, *Dodonaea viscosa.*

MONTANE SUBTROPICAL FORESTS

GROUP 8 - SUBTROPICAL BROAD LEAVED HILL FORESTS

As there are considerable differences between the northern and southern representatives of subtropical forests, they will be described and discussed as two subgroups, viz.

Group 8 A - Southern subtropical broad leaved hill forests

Group 8 B - Northern subtropical wet hill forests.

Subgroup 8 A Southern Subtropical Broad Leaved Hill Forests

1. NOMENCLATURE

Kerala Madras Mysore Bombay	Shola (part) Transition forest.
Rajastan Madhya Pradesh Orisa	Hill top forest

2. GENERAL DESCRIPTION

The forest presents two decidedly different aspects according as to whether it occurs with a well-distributed fairly high rainfall as on the higher hills in the south whese

the adjoining tropical forest is of the wet evergreen type, or with a lower unequally distributed rainfall with a marked dry season, where the adjoining tropical forest is of a dry deciduous type; the letter conditions prevail on all the more isolated hills of the central part of the country and usually the original vegetation has been so altered by biotic influences that its from and composition can only be inferred. Accounts are given under the three types distinguished below.

3. DISTRIBUTION

Subtropical types are met with in a zone between about 1,000 m. and 1,700 m. on the higher hills of South India, and also above 1,000 m. on the higher hills of Central India including outliers such as Mt, Abu (1,360 m.) and Parasnath though mostly only in vestigial form

4. LOCALITY FACTORS

TEMPERATURE - The mean annual temperature lies roughly between 18 and 24° C and the mean January temperature about 5° lower. Frost is practically unknown. Data are given for Mercara at 1,158 m. Coonoor at 1,746m. Mahabaleshwar at 1,381 m. and Mt. Abu at 1,200 m.

TEMPERATURE (CENTIGRADE)
SOUTHERN SUBTROPICAL BROADLEAVED HILL FORESTS

Month	Mysore MERCARA			Maharashtra MAHABALESHWAR		
	1143 m. mean	Mean max.	Mean min.	1382 m. mean	Mean max.	Mean min.
Jan.	19·6	25·1	14·0	18·8	23·6	13·9
Feb.	21·0	27·0	15·0	19·9	25·2	14·6
March	22·7	29·0	16·4	22·5	28·0	17·0
April	23·2	28·7	17·7	24·3	29·7	18·9
May	22·4	26·7	18·1	23·5	28·8	18·2
June	19·8	22·3	17·3	19·2	21·4	16·9
July	18·6	20·4	16·7	17 7	18·6	16 8
Aug.	18·7	20·7	16·7	17·6	18·7	16·4
Sept.	19·3	22·1	16·6	17·9	19·9	16·0
Oct.	20·5	24·1	16·9	19·9	23·4	16·3
Nov.	19 9	23·9	16·9	19 1	23·3	14·9
Dec.	19·1	23 8	14·3	18 1	22·6	13·6
M. A. T.	20·4			19.9		
Annual mean max.	24·5			23·6		
Highest record	35·0			26·1		
Annual mean min.	16·3			16·1		
Lowest record	8·9			6·7		
No. of years	60			60		

TEMPERATURE (CENTIGRADE)
SOUTHERN SUBTROPICAL BROADLEAVED HILL FORESTS

Month	Madhya Pradesh PACHMARHI			Madras COONOOR		
	1075 m. mean	Mean max.	Mean min.	1748 m. mean	Mean max.	Mean min.
Jan.	15·5	22·2	28 7	13·7	19·0	8 3
Feb.	17·2	24 1	10·4	15·3	21·0	9·5
March	22 1	28·9	15·2	17·0	22 7	11·3
April	26·9	33·3	20 4	18·7	23·7	13·7
May	29 7	35·4	23·9	19·8	24·6	15·0
June	26·6	31·0	22·2	18·8	22·6	15 1
July	22·3	24·7	19·9	18·3	21·6	15·1
Aug.	21·6	23·8	19.3	18·0	21 6	14 3
Sept.	22·1	25·3	18 9	17·6	21·7	13·5
Oct.	20·8	26·6	14·9	17·2	20 9	13·4
Nov.	17·0	23·6	10 4	15·7	19·4	11·8
Dec.	14·8	21·8	7·7	14·1	18·7	9·6
M. A. T.	21·4			17·0		
Annual mean max.	26·7			21·4		
Highest record	40·6			29·4		
Annual mean min.	16·0			12 6		
Lowest record	1·1			2·2		
No. of years	60			10		

RAINFALL AND HUMIDITY - The range of average annual rainfall is a wide one whilst the length of dry season varies from virtually none to seven months. These differences tend to be offset by relatively high humidity and effect the vegetation less than might be expected, though closer study would probably reveal differences sufficient to render subdivisions advisable. The different distributions at Gudalur and Coonoor on the north - west and south of the Nilgiri massif are not worthy.

RAIN FALL (MILLIMETRES)
SOUTHERN SUBTROPICAL BROADLEAVED
HILL FORESTS

Months	Madras COONOOR 1746 m.	Madras GUDALUR 1067 m.	Mysore MERCARA 1143 m.	Maharashtra MAHA-BALESHWAR 1382 m.
Jan.	63	9	4	4
Feb.	73	7	6	3
March	82	19	19	4
April	149	71	65	30
May	106	131	132	41
June	71	413	648	1084
July	66	737	1095	2675
Aug.	127	443	681	1857
Sept.	90	203	281	730
Oct.	257	176	211	151
Nov.	285	82	76	40
Dec.	142	18	18	7
Total for year (M.A.R.)	1,512	2,309	3,237	6,635
No. of rainy days	85	114	132	120
No. of months less than 50 mm.	0	4	4	7
M. A. Humidity	69	—	80	69
No. of years	10	64	60	60

RAIN FALL (MILLIMETRES)
SOUTHERN SUBTROPICAL BROADLEAVED HILL FORESTS

Month	Madhya Pradesh PACHMARHI 1075 m.	Madhya Pradesh CHIKALDA 1097 m.
Jan.	16	15
Feb.	17	10
March	14	12
April	9	9
May	16	21
June	230	240
July	666	511
Aug.	606	440
Sept.	360	305
Oct.	58	88
Nov.	19	34
Dec.	11	15
Total for year M. A. R.	2022	1701
No. of rainy days	79	77
No. of months less than 50 mm.	7	7
M. A. Humidity	57	—
No. of years	60	66

SOIL AND TOPOGRAPHY - These types are restricted to hilly districts though rolling plateau country is included. A variety of rocks is encountered including basaltic trap (Mahabaleshwar). The soil intermediate in the type between the tropical red earths and the temperate brown earths. There may be a thick lateritic cap over trap rock and a thpically lateritic soil (Mahabaleshwar), indicating a tropical rather than temperate history.

5. GENERAL FLORISTICS

In the south, the flora is a mixture of that of the wet tropical forest, especically of the wet evergreen type, with that of the temperate forest the former element usually predominating. Further north, it is the dry tropical types that extend even to the tops of the hills, some species tending to dominate with a varying proportion of plants of temperate type among the subordinate vegetation. *Eugenia (Syzygium)* are characteristic genera and *Lauraceae* are very generally present. *Memecylon* and other *Melastomaceae* usually occur. Several studies of the phytogeography of these hill tops have been made revealing affinities with both Western and Eastern Himalayan floras. Genera of northern origin include *Clematis*, *Hypericum*, *Lonicera* and *Rubus*.

6. SUBDIVISIONS

These forests have all been subject to much interference and apart from their floristics have been inadequately

studied to permit of a reliable classification. The following types are provisionally differentiated :—

C1 — Nilgiri subtropical hill forest.

E1 — Reed brakes (*Ochlandra)*

DS1 — South Indian Subtropical hill savannah woodland.

C2 — Western subtropical hill forest.

C3 – Central Indian subtropical hill forest

TYPE 8A/CI

C1 — SOUTHERN SUBTROPICAL HILL FOREST

NOMENCLATURE - Transition belt of shola forests.

DESCRIPTION - Evergreen forest that has been described as 'stunted rain forest', similar to the tropical rain forest but not so luxuriant, the trees being smaller and with less shapely boles, and often festooned with herbaceous and cryptogamic epiphytes. A dense undergrowth of *Strobilanthes*, etc. is frequently present.

In S. India, notably on the *slopes* of the higher Nilgiri and Palani Hills no marked zonal differentiation of tropical, subtropical and temperate vegetational types is discernable; the first and last types are definite enough but they appear

to merge imperceptably into each other without any intervening zone with characteristics differing from both. This is comparable in some respects with the frequent absence of well marked semi-evergreen forest between evergreen and deciduous forests, and the explanation is perhaps similar viz, .that it is due to the fact that the topography is such that the transition would in any case occupy relatively little space and the tropical and temperate froms would always be within a few miles of each other. In S. India the temperate forests are of a dense low evergreen type and the tropical wet evergreen falls off in height and general luxuriance with ascending elevation till the two are more or less alike. The transition zone has in any case been considerably affected by human interference, much of it having been subjected to shifting cultivation, burning or clearing for gardens. On the steeper slopes with shallow soil and rocky outcrops poor decidous forest of a savannah type may replace the evergreen.

Distribution - Between 1,200 and 1,750 m. on the slopes of the Nilgiri, Anamalai and Palani Hills of Madras and Kerala extending some distance northwards doubtfully to Mercara (Coorg.)

Locality Factors - Temperature data are given on pp. 307, 308 for Coonoor and Mercara, and the rainfall data for Coonoor, Mercara, and Gudalur (which is at the lower extreme for the type on the west side of the Nilgiri massif). The rainfall may vary from 2,000 to 5,000 mm. with a varying amount from the Northeast monsoon.

FLORISTICS

(i) Silent Valley. Palghat Division. Kerala, Over, 1,550 m.

I & II *Calophyllum elatum, Actinodaphne hookeri, Litsea stocksii, Cinnamomum sulphuratum, Canthium dicoccum, Engenia* spp.*, *Rhododendron nilagiricum, Gaultheria fragraitissima*

III *Strobilanthes* spp.

ECOLOGICAL NOTE :

This forest is protected from fire by the evergreen forests below. Much of it has been cleared for tea and coffee plantations. It may be viewed as a possible climatic climax formation though ill- defined mainly transitional. Where the rainfall is low and fires occur, it change into the next type described below (8A/ C2)

(ii) Thenmalai and Trivandrum, Kerala Circle, 1200 m. (Transition to tripical).

I. *Eugenia wightiana**, *E. arnottiana**, *Microtropis wallichiana, Kurrimia indica, Euphoria longana. Turpinia cochinchininensis, Meliosma wightii, Semecarpus travancorica, Linociera* spp., *Elaeocarpus venustus, Machilus. macrantha. Neolitsea zeylanica, Celtis* spp., *Heritiera papilio, Gordonia obtusa, Ficus arnottiana* etc.

II. *Eugenia montana*, *Canthium dicoccum*, *Memecylon* sp., *Heptaplaeurom wallichianum*.

IIa. *Ochlandra* sp.

III *Strobilanthes* sp.

V *Calamus* sp.

TYPE 8A/E1

E1 — *OCHLANDRA REED BRAKES*

Description - Impenetrable thickets 3 to 5 m. high with scattered overwood of evergreen trees.

Distribution - Near the summit of the Tirunelveli hills above the evergreen forest and along the higher slopes at 300 m and above and especially along streams.

Locality Factors - Restricted to moist area.

Floristics

I. *Vernonia monosis* (o), *Eugenia* spp. (o), *Palaquinm ellipticum* (o),

IIa. *Ochlandra wightii*, *O travancorica**, *Bentinckia coddapanna* (a) (on rocky ground)

ECOLOGICAL STATUS

Not determined bnt appears able to invade chancc gaps in the evergreen forest.

TYPE 8A/DS1

DS1 - SOUTH INDIAN SUBTROPICAL HILL SAVANNAH (WOODLAND)

DESCRIPTION - Au open savannah forest with tall coarse grass even 2—3 m. high and scattered trees nearly all deciduous and fire hardy shrubs; *Phoentx humilis* is particularly characteristic.

DISTRIBUTION - Between 1,100 m. and 1,700 m on the slopes of the Nilgiri and Palani Hills of Madras and Kerala.

LOCALITY FACTORS - Temperature and rainfall as for Kotagiri and Kudalur in the Nilgiri Hills (p. 310). The rainfall varies from 1.500 mm upwards and is well distributed. On hilly country, especially on steep slopes but often also on undulating plateau land. Mostly burnt at frequent intervals usually annually.

FLORISTICS

I. *Dalbergia latifolia* (lower levels), *Anogeissus latifolia* (lower levels)

II. *Embilica officinalis*, *Wendlandia notoniana*, *Olea dioica*.

III. *Phoenix humilis**.

IV. Heavy grass.

NOTE : The type is unquestionably a degradation stage derived from the subtropical evergreen by clearing or burning or both and maintained by periodic burning. Only fire hardly trees occur. Locally on shallow soils the climax is perhaps only semi-evergreen or moist deciduous forest,

TYPE 8A/C2

C2—WESTERN SUBTROPICAL HILL FOREST

DESCRIPTION - Most of the forest has been fundamentally altered by shifting cultivation or lopping. Where properly developed, it is a dense evergreen wood of mixed species and low height generally not exceeding 15 m. though locally upto 20 m. Trees of girth upto 2 m. occur, of spreading habit and usually hollow. There may be scattered emergents of *Tetrameles*, *Sterospermum* etc.

DISTRIBUTION - Above about 1,000 m. in the northern part of the Western Ghats in Bombay State.

LOCALITY FACTORS - Climatic data are given on p 310 for Mahabaleshwar which experienced an exceptionally heavy rainfall The dry season is as long as seven months though humidity is fairly high. The rock at Mahabaleshwar is basaltic trap overlaid with a thick lateritic cap from which the soil derives its chief characteristics mostly unfavourable to good tree growth.

FLORISTICS

(i) Mahabaleshwar, Maharashtra.

I/II. *Syzygium cumini**, *Actinodaphne hookeri*, *Memecylon umbellatum**, *Randia, dumetorum*, *Flacourtia, latifolia*, *Terminalia chebula*, *Olea dioica–Glochidion hohenackeri*, *Pouteria tomentosa*

III *Canthium dicoccum*, *Scutia myrtina* (*thorny*), *Carvia callosa* (*Strobilanthes callosus*). *Pogostemon plectranthoides*, *Lasiosiphon eriocephalus.*

IV. *Elaeagnus latifolia*, *Allophyllus cobbe*, *Capparis pedunculosa*, *Zizyphus rugosa*, *Pavetta indica*

NOTE : The forest is full of blanks due to old *kumris* which are very slowly recolonized by *Pteridium equilinum* followed by *Crotalaria retusa*, *Lasiosphon eriocedhalus*, *Randia dumetorum* etc. which also occur generally on poor rocky sites, and ultimately by *Syzygium* and other climax species PURI & MAHAJAN (1960) differentiate 3 more communities characterised by the predominance to *Terminalia chebula*, *Randia dumetorum* and *Artocarpus hirsuta*, respectively, but they do not seem to be more than anthropogenic variants. SATYANARAYANAN (1958) recorded *Dysoxylum binecteriferum* as a frequent emergent.

Very similar vegetation is found at Bhimahsankar (PURI & VASVADA) Although these forests occur on a plateau at only 760 m., they closely resemble those of Mahabaleshwar. The rainfall is over 5,000mm. humidity high and temperatures moderate (Max. 28°C Min. 20°C).

TYPE 8A/C3

C3 — CENTRAL INDIAN SUBTROPICAL HILL FORESTS

NOMENCLATURE

Madhya Pradesh Bihar Orissa Rajasthan	Hill top forests

DESCRIPTION

The sites occupied being exposed and often with poor soil, and long subject to human settlement aed grazing, the residual forest is mostly of an inferior type, the trees being short-boled and branchy. It is doubtful if any climax forest survives though the vegetation of sheltered glens and steep and narrow gullies probably represents it to some extent. The average sites carry a more xerophytic vegetation which in its present degraded from closely resembles the tropical dry deciduous forest though usually with a rather higher proportion of evergreens.

DISTRIBUTION

On hill tops over about 1,200ms in Madhya Pradesh Orrisa and Bihar such as Pachmarhi, Chikalda and the Bailadila Hills, probably also Mt. Abu and Parasnath.

LOCALITY FACTORS

TEMPERATURE - The mean annual temperature ranges from 18° to 24°C the January mean being about 5°C lower and the Map mean rising to about 23°C reflecting the much onger dry season. Light forst is occasionally recorded at the higher elevations as at Mt. Abu (1.200m.)

RAINFALL AND HUMIDITY - Rainfall is definitely lower than in the South Indian type though still relatively high, and is typically over 1,500 mm. mainly from the S W monsoon: there is, however, a long dry season, usually lasting seven month which is not compensated by adequate humidity as the monthly average drops as low as 26 (even 20 at moon)

SOIL AND TOPOGRAPHY - Soils are typically shallow where the topography is steep as in Mt Abu, but of fall depth on the flatter tops as in Pachmarthi, laterite is usually Pachmarthi is mainly on sandstones. but a wide variety of rocks are represented

FLORISTICS

Owing to the far reaching effects of clearing, grazing and burning there is little left of the climax vegetation, but

it would appear to consist mainly of tree species extending up from the mixed deciduous type below with predominance of *Syzygium cumini*, *Manilkara*, *hexandra*, *Ficus* spp., *Mallotus* etc and shrubby undergrowth including *Strobilanthes*, *Ixora*, *Indigofera*, etc and often lianes such as *Bauhinia*, *Vitis* and *Clematis* Representatives of northern genera such, as *Hypericum*, *Rubus*, *Berberis* are found, as well as *Pteridium*

(i) Pachmarthi, Madhya Pradesh.

The foirly extensive plateau lying at somewhat. over 1,000m. with peak upto 1,350m. might be expected to carry subtropical vegetation. Actually typical tropical dry deciduous forest extends right upto the rim whilst the plateau itself has been so greatly influenced by clearing etc. as to leave it uncertain what it carried originally. Evergreen *Manilkara hexandra* Mangifera** and *Syzygium cumini** are the conspicuous indigenous trees.

(ef RAO & NARAYANASWAMY (1960), KAPOOR & YADAV (1962). and HEWETSON (1940).

(ii) Central Valley Bailadia Range, Orissa (NOT SEEN).

I. *Carallia-Calamus-Cyathea* association MOONY (1941*) *Carallia brachiata*$_*$ (f).

II. *Machilus macrantha* (va) *Neolitsea zeylanica* (a), *Homalium nepalense*, *Elaeocarpus pruniformis* (a) *Cedrela toona*, *Symplocos laurina* (f), *Syzygium cumini* (o), *Mallotus philippensis* (o),

IIa. *Cyathea spinulosa** (f), *Alsophila glabra* (a), *Phoenix humilis* (a).

III. *Memecylon edule* (f), *Glochidion valutinum* (la) *Gymnosporia baladiliana* (la).

IVa. *Pteridum aquilinum*,

V. *Gnetum scandens* (la), *Calamus latifolia* (a) *Clematis smilacifolia*, (MOONEY, 1942).

ECOLOGICAL NOTE :

This clearly not the climatic climax but probably included many species that contributed to it Fuller details and discussion are available in the reference given. Similar vegetation has also been recorded by MOONEY (1941) for ravines at 750-1,000 m. in the Kalahandi Hills, and (1944) of the pats of Ranchi. Palamau,

TYPE 8A/DS

DEGRADATION STAGES OF SOUTHERN SUBTROPICAL BROADLEAVED HILL FORESTS

The subtropical forest of South Indian and Western Ghats are mostly on steep hillsides with only occasional

easier gradients which have mostly been cleared for cultivation at one time or other. The residual vegetation or regrowth has not been studied. Over the rest of the Peninsula, only hilltops are in question and especially where they are relatively flat, they have mostly been completely denuded cf tree growth, hevily grazed and burnt and are now grassland with only scattered fire resistant trees, and patches of low forest or scrub in moister or sheltered spots. This residual vegetation is of little importance as forest.

MONTANE WET TEMPERATE FORESTS

Subgroup II A. 1YPE C1. Southern Montane Wet Temperate Forests

1. NOMENCLATUR

Madras	Hill shola
Kerala	Forest

2. GENERAL DESCRIPTION

A closed evergreen forest, the trees being mostly short-bold and branchy though often attaining a considerable girth. The height of the forest is relatively low, rarely exceeding 6 m. The crowns are usually very dense and rounded with entire coriaceous leaves which tend to be red to a verying degree when young, giving a range of colours which is one of the most consipicuous features of the type. The branches are clothed with mosses, ferns and other epiphytes, and woody climbers are common. These is no, marked differentiation of canopy layers, but a continuous series from undershurbs shurbs to the large trees. There is a considerable admixture of species pure crops of even moderate extend being absent. The transition to the subtropical forest below is usually ill defined.

The forest is usually found in patches (sholas) in the more sheltered sites on rolling grassland the origin of which s discussed below.

3. DISTRIBUTION

The higher hills of Madras and Kerala on the Nilgiri, Anamalai, Palani and Tirunelveli hills from about 1.500m. upwards (Very similar forest is met with in the higher parts, of Ceylon, where it has been less altered by biotic influences).

4. LOCALITY FACTORS

The climate in this type is perhaps the most equable experienced in India and is conditioned by the montan- situation well within the tropics combined with a well distributed rainfall from both monsoons. Actually condie tions vary considerably particularly with regard to the total rainfall and its detailed seasonal distribution. February is typically the driest month.

TEMPERATURE - Data are given below for Ootacamund and Kodaikanal at about 2,300 m. in the higher part of the type and for Wellington at about 2,000m, It may be noted that with the same mean temperature for the year at Ranikhet in the W Himalayas (18.3°C) the annual range between the mean highest and lower temperatures of the year is only 9°C for Wellington as compared with 18°C for Ranikhet difference is also will illustrated by the range of monthly means which is 13° C to 19° and 8° C to 22°C respectively.

TEMPERATURE (CENTIGRADE)
SOUTHERN MONTANE WET TEMPERATURE FORESTS

Month	Madras OOTACAMUND			Madras COONOOR		
	2245 m. mean	Mean max.	Mean min.	1749 m. mean	Mean max.	Mean min.
Jan.	12·2	18·8	6·6	13·7	19·0	8·3
Feb.	13·2	19·7	6·6	15·3	21·2	9·5
March	15·0	21·1	8·8	17·0	22·7	11·3
April	15·7	21·9	9·5	18·7	33·7	13·7
May	16·4	21·3	11·4	19 8	24·6	15·0
June	14·6	17·8	13 3	18·8	22·6	15·1
July	13·9	16·6	11·2	18·3	21·6	15·1
Aug.	14 1	17·1	11 1	18·0	21 6	15·1
Sept.	14·3	18·1	10 6	17·6	21·7	13·5
Oct.	14·2	18·1	10·3	17·2	20 9	13·4
Nov.	13·3	17·6	1·9	15·7	19·4	11.8
Dec.	12·7	18·3	6 6	14·1	18·7	9·6
M. A. T.	14 2			17·0		
Annual mean min.	18·9			21·4		
Highest record	26·1			29·4		
Annual mean min.	9·4			12·6		
Lowest record	1·7			2·2		
No. of years	40			10		

TEMPERATURE (CENTIGRADE)
SOUTHERN MONTANE WET TEMPERATURE FORESTS

Month	Madras KODAIKANAL		
	2343 m. mean	Mean max.	Mean min.
Jan.	12·4	16 8	8.1
Feb.	13·2	17·8	8·6
March	14 6	19·0	10·1
April	15 9	20·2	11 7
May	16·4	20·1	12·6
June	14·9	18·1	11 8
July	14·0	16·8	11·2
Aug.	14·1	17·1	11·1
Sept.	14·1	17·1	11·1
Oct.	13·7	16·7	10·7
Nov.	12·9	16·1	9·7
Dec.	12·3	16 5	8·4
M. A. T.	14·0		
Annual mean max.	17·7		
Highest record	27·8		
Annual mean min.	10·4		
Lowest record	2·8		
No. of years	50		

Rainfall - From 1,500 mm. upto 6,250 mm. or even more. The S. W. monsoon gives rain from April unwards with a maximum in June-July. This is followed by a drier August/September and then the N. E. monsoon sets in giving a second maximum in October. December to March is the driest period when there may be less than 50 mm. per month. The relative importance of the two monsoons depends on situation and exposure,

RAIN FALL (MILLIMETRES)
SOUTHERN MONTANE WET TEMPERATE FORESTS

Months	Madras OOTACAMUND 2245 m.	Madras WELLINGTON 1829 m.	Madras COONOOR 1749 m.	Madras KODAIKANAL 2343 m.
Jan.	24	35	63	81
Feb.	13	38	73	39
March	27	56	82	46
April	83	90	149	122
May	155	97	106	162
June	162	83	71	108
July	192	94	66	118
Aug.	138	104	127	178
Sept.	130	152	90	195
Oct.	204	284	257	260
Nov.	130	177	285	259
Dec.	47	102	142	131
Total for year (M. A. R.)	1303	1312	1512	1689
No. of rainy days	99	88	85	107
No. of months less than 50 mm.	4	2	0	2
M. A. Humidity	74	—	69	76
No. of years	55	30	10	40

SOIL AND TOPOGRAPHY- The underlying rock is crystaline throughout mostly gneissic. This weathers to a reddish or yellow clayey soil topped by a varying depth of black soil rich in humus In hollows and other wet sites, a regular peat is formed When the forest cover is removed, this rich black soil is liable to be rapidly eroded with a marked drop in fertility.

The home of the type is on the rolling downs of the higher plateaux, a configuration rarely met with elsewhere in India (Khasi hills). As noted, the forests at present occupy the sheltered folds in the hills.

WIND-Eaposure is an important factor in the development of these temperate evergreen forests and its effects are very obvious in the form of these and the appearance of the windward edge of the *sholas*.

FIRE AND GRAZING - In the dry season in February-March the grasslands get dry and inflammable and the greater part of them is burnt annually. This has happened as far back as we have any information and has unquestionably exerted a very great influence on the present distribution of the very fire tender evergreen forest. Burning completely stops regeneration of practically every tree species except *Rhododendron* and every fire eats in a little all along the periphery of the *sholas*, Normadic graziers have occupied the plateaux for a very long time and have burnt the grass for the sake of the early flush of new growth that follows a fire. and it is unquestionable that the forest now occupies a far smaller proportion of the area it once did.

5. FLORISTICS

The flora is a varied one including element or both tropical and temperate origin; *Ternstroemiaceae* are well represented and *Eugenias* are important together with *Meliosma*, *Eurya*, *Symplocos* and *Lauraceae*. *Magnoliaceae* are represented by *Michelia* and with it are found such genera as *Ilex* and *Euonymus*. *Rhododendron nilagiricum* is as common and conspicuous as in the Himalayas and the *Ericaceae* are represented by *Gaultheria* and *Vaccinium*.

(i) Sholas near Ootacamund, Niligiri Hills, Madras.

I. *Ternstroemia gymnanthera**, *Eugenia calophyllifolia*, *E. arnottiana*, *E montana*, *Michelia nilagirica*, *Gordonia obtusa* *Xantolis tomentosa* (*Sideroxylon tomentosum*). *Ilex wightiana*, *Meliosma wightii*, *Elaeocarpus* spp, *Photinia montana*, *Cinnamomum wightii*, *Litsea wightiana*, *Rhododendron nilagiricum**, *Euonymus crenulatus*, *Glochidion neilgherrense*, *Symplocos laurina* etc.

II *Turpinia cochinchinensis*, *Rhamnus wightii*. *Viburnum erubescens* etc. *Ligustrum* spp.

III. *Gaultheria fragrantissima*, *Psychotria congesta* *Vaccinium leschenaultii*. *Mahonia leschenaultii* (*nepalemsis*). *Strobilanthes* spp.

IVa. *Impatiens* spp.

V. *Rosa leschenaultiana*, *Clematis wightiana*, *Rubus* spp , *Schefflera* spp., *Elaeagnus latifolia*, *Toddalia asiatica*.

NOTE : RANGANATHAN (1938) describes the considerable variation met with in the appearance and floristics of different parts of the plateau. Doubtless subdivision of the type will be made in due course with recognition of several associations.

6. NOTE

Whilst it is generally agreed that the *sholas* have been greatly reduced in extent even in recent times, there has been considerable controversy over the ecological status of the grassland. RANGANATHAN (1938) was of opinion that it is a climatic climax equally with the *shola* forest. Whilst tree growth may have been inhibited locally by frost, particularly in depressions where excessively swampy conditions may also prevail, we are of opinion that these adverse conditions have mainly been brought about by forest destruction by clearing fire and grazing through the centuries. The grassland is accordingly here viewed as a stable degradation stage though possible edaphic or physio graphic climax status might be accorded over restricted areas. Exposure to wind exerts an influential check on tree growth and renders large clearings slow to recover though burning is the primary inhibitory rfactor. Grasses occupy all clearings and periodic fires extend every grass

patch eating away the forest till it is restrited to the damper sites. Introduced plants such s *Ulex* and *Sarothamnus* have occupied a lot of the ground lost to the forest apart from the planted *Eucalyptus* and *Acacias*, whilst the Nilgiri weed, the *Eupatornum riparium* appears to be checking the spread of fire into the *sholas* by forming a dense green belt along their edges. *Rhododendron nilagiricum* is practically the only tree which can persist in and colonise the burnt grasslands. and patches of *Gaultheria* are also characteristic. Locally *Rhodomyrtus*, *Hypericum*, *mysorense*, *Dodonaea viscosa*, various *Melastomaceae* and *Rupus* spp. from shrub communities the origin and development of which also need study.

DEGRADATION STAGES OF SOUTHERN WET TEMPERATE FORESTS

TYPE DS1

SOUTHERN MONTANE WET SCRUB

Distribution - Considerable areas on the down occupying sites where shola forest probably existed earlier. A depauperated from also occurs on shallow tocky soils.

Description - Low evergreen scrub of varying density often with bracken fern and seedings or stunted growth of *shola* species, notably *Rhododendron* and *Eugenia arnottiana*

FLORISTICS

Rhodomyrtus (a), *Hypericum mysoreuse* (a) *Dodonaea viscosa* (la), *Mahonia leschenaultil*, *Berberis tinctoria*, *Rubus* spp., *Strobilanthes* spp, and *Pteridium aquilinum*.

ECOLOGICAL STATUS:

There is every indication that most of this scrub would with protection gradually progress to the *shola* climax.

TYPE DS2

SOUTHERN MONTANE WET GRASSLAND

DISTRIBUTION - Over large areas on the rolling down_ land e.g. Wenlock Downs.

LOCALITY FACTORS - The highest parts and many despressions are subject to annual frost. Grazing is moderate to heavy. Fires are frequent though less common in parts as on the Wenlook Downs.

FLORISTICS - RANGANATHAN

I/II. Nil

VIb. *Bothriochloa pertusa, Ischaemum pilosum Themeda cymbaria, T, triandra, Cymbopogon polyneuros, Eragrostis nigra, Tripogon bromoides.*

ECOLOGICAL NOTE:

Though some writers have viewed this as climatic climax grassland, it is here considered as the ultimatie degradation stage, stable under the current grazing and burning.

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